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NAS PENSACOLA
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TECHNICAL MEMORANDUM REGARDING PRELIMINARY RESULTS OF REMEDIAL INVESTIGATION AT SITE 2 NAS PENSACOLA FL

11/1/1994

ENSAFE ALLEN AND HOSHALL

TECHNICAL MEMORANDUM

TO: NAS Pensacola Tier I Team

FROM: EnSafe/Allen and Hoshall

DATE: November 1994

SUBJECT: Preliminary Results — Site 2 Remedial Investigation

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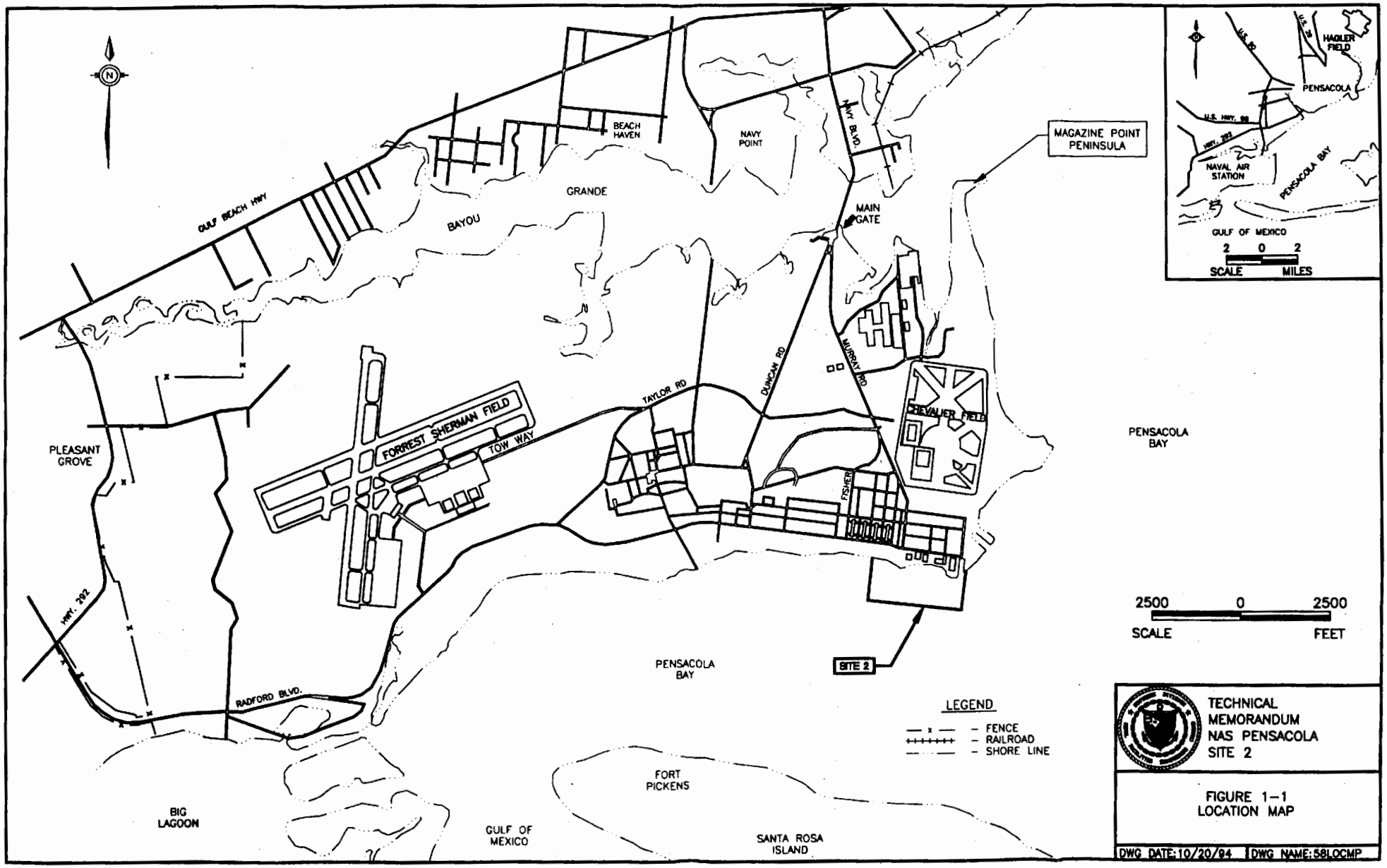
FOREWORD

The following technical memorandum presents preliminary results and conclusions for information collected as part of the Remedial Investigation at Site 2. The information used was collected during Phase I and Phase IIA of the RI process. Based on data results from these portions of the study a subsequent Phase IIB was initiated. A decision to continue with subsequent work, Phases IIB and III, will hinge on the conclusions drawn from this information.

1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) program, a Remedial Investigation (RI) was conducted at Site 2, the waterfront area, at the Naval Air Station (NAS) Pensacola in Pensacola, Florida. This investigation took place from July 15 to December 9, 1993. Site 2 is on the southeastern shoreline of NAS Pensacola, along the Pensacola Bay waterfront. Site 2's location is shown on Figure 1-1. This site encompasses the area of nearshore sediments along the southeast base waterfront, where 56 sewer stormwater and stormwater outfalls exist. The southeast waterfront is dominated by a protective seawall with numerous seaplane ramps and large adjacent paved parking aprons. The seawall is approximately 3 to 4 feet high, and rests on a concrete platform. The 56 outfalls range in diameter from 1 to 42 inches (E&E 1991). The seawall also accommodates numerous scuppers to drain surface water from the adjacent parking areas. The waterfront outfalls begin near the McDonald's Restaurant, and extends east to Allegheny Pier. Many of the outfalls here discharged untreated industrial wastes into Pensacola Bay from approximately 1935 to 1973, when NAS Pensacola's industrial waste stream was diverted to the Industrial Wastewater Treatment Plant (IWTP [E&E 1992]). Previous studies have described the bay sediments as fine sands to a water depth of 30 feet and silty sands and muds from there to the deepest parts of the ship channel (E&E 1992). However, few sediment samples have been collected in the immediate area at Site 2.

The objectives of the RI are to determine the sources, nature, magnitude, and extent of any sediment and surface water contamination, and to facilitate the evaluation of human health and ecological risk posed by contaminated media onsite through the baseline risk assessment (BRA) process.

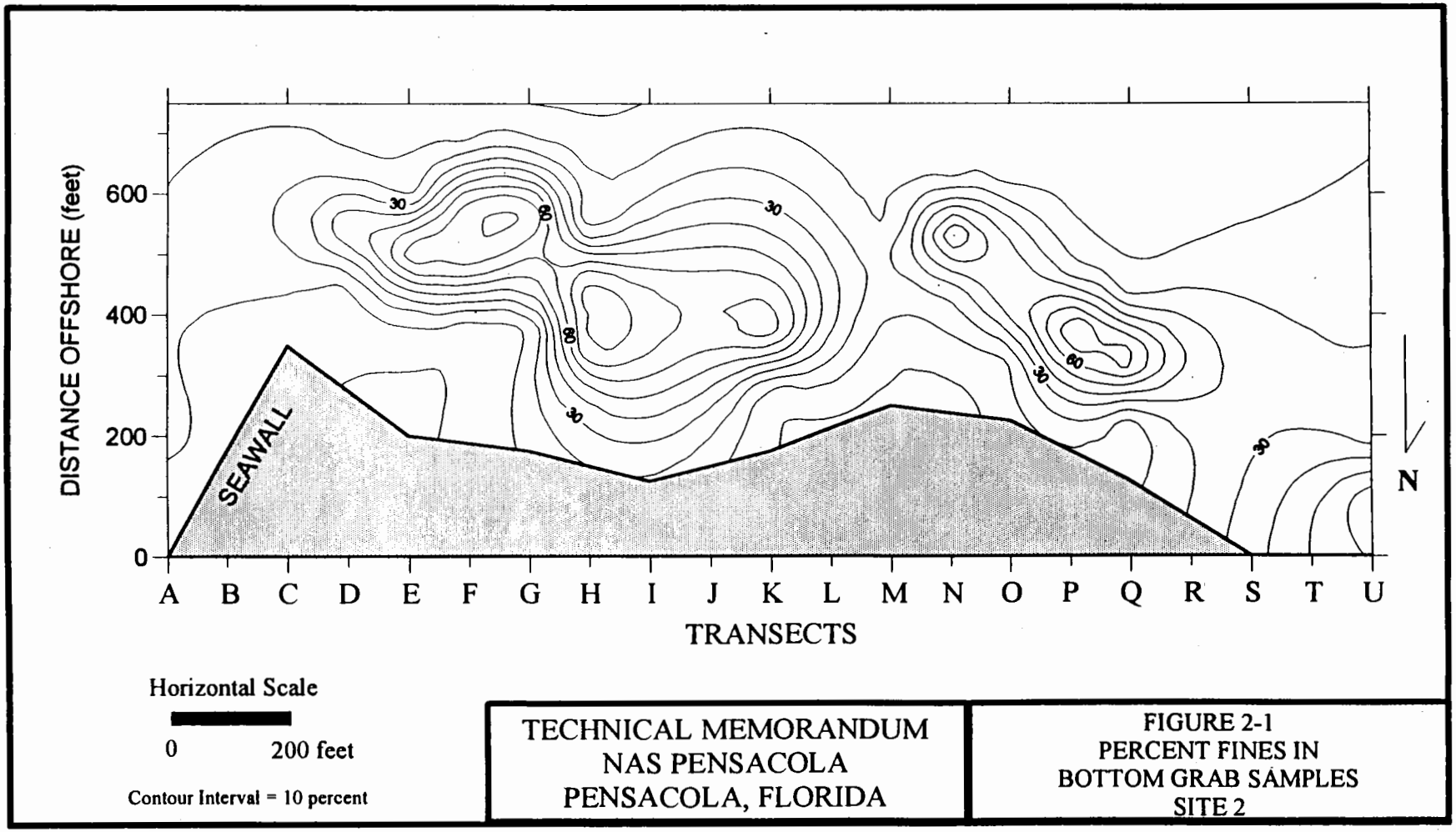

N
GULF BEACH HWY
BEACH HAVEN
NAVY POINT
NAVY BLVD.
MAGAZINE POINT PENINSULA
GRANDE BAYOU
MAIN GATE
DUNCAN RD
MURRAY RD
TAYLOR RD
FORREST SHERMAN FIELD
TOW WAY
CHEVALIER FIELD
FISHER
PLEASANT GROVE
HWY. 292
RADFORD BLVD.
PENSACOLA BAY
SITE 2
BIG LAGOON
GULF OF MEXICO
FORT PICKENS
SANTA ROSA ISLAND
LEGEND
- x - FENCE
+++++ RAILROAD
SHORE LINE
2500 0 2500
SCALE FEET
U.S. 90
U.S. 29
HAGLER FIELD
PENSACOLA
U.S. HWY. 98
HWY. 292
NAVAL AIR STATION
PENSACOLA BAY
GULF OF MEXICO
2 0 2
SCALE MILES
TECHNICAL MEMORANDUM
NAS PENSACOLA
SITE 2
FIGURE 1-1
LOCATION MAP
DWG DATE:10/20/94
DWG NAME:58LOCMP

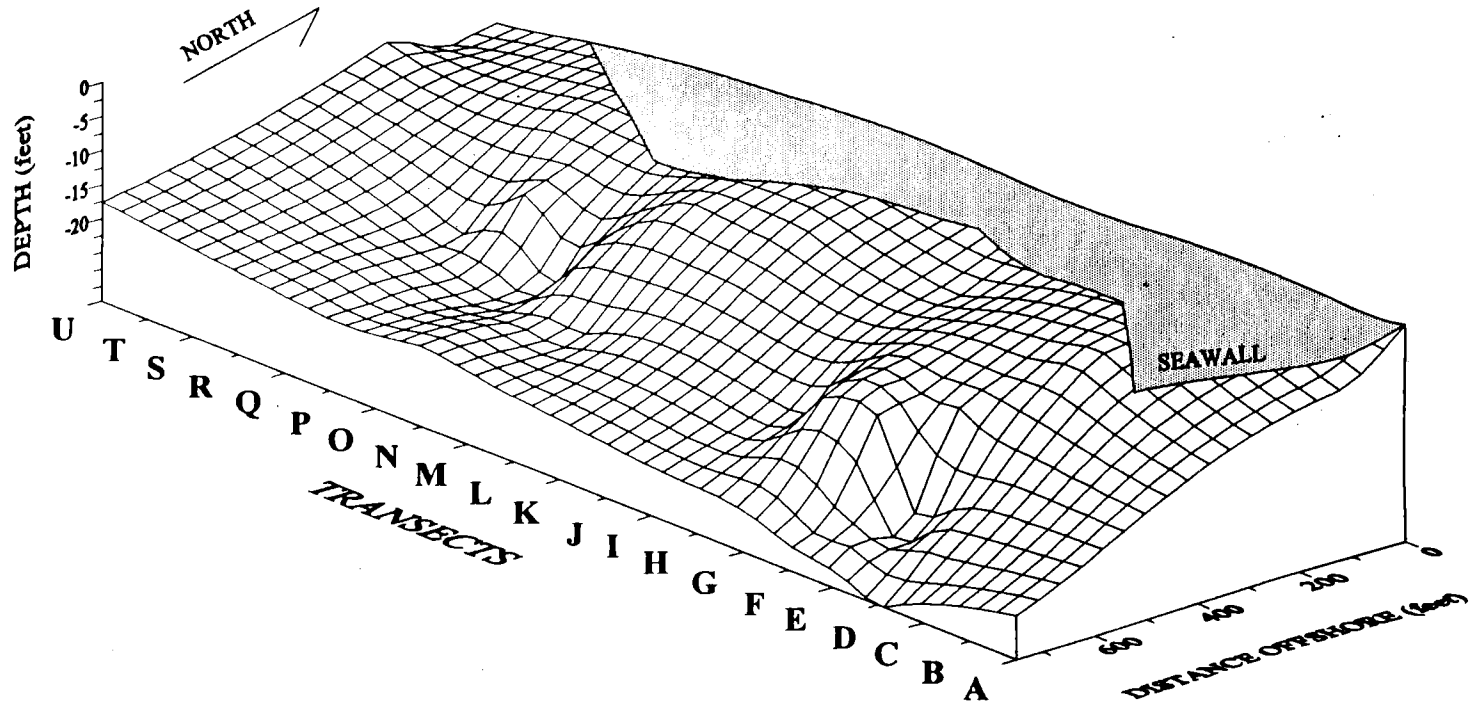
For this memorandum, a cursory examination of data collected from water and sediment across Site 2 is presented. Data collected were compared to established Applicable or Relevant and Appropriate Requirements (ARARs) or screening standards to assess potential risk to human and ecological receptors.

2.0 METHODS

Site 2 was assessed in accordance with a Navy, U.S. Environmental Protection Agency (USEPA) and Florida Department of Environmental Protection (FDEP) approved work plan which outlined an extensive sediment, surface water, biota and groundwater investigation, and sampling program for Site 2. This phased approach included a preliminary assessment to determine the distribution of total organic carbon (TOC) and grain size (Figure 2-1) in sediments across the site, in addition to water depth (Figure 2-2). The results of this preliminary sediment survey subsequently were used to select areas within Site 2 suspected of having relatively higher contamination concentrations. These higher probability areas were then selectively sampled for surface water and sediment chemistry (Figure 2-3). This method appeared to reduce randomness in the sampling, but a random component still existed because of the changing nature of the area's sediments.

Surface water and sediment samples were collected for contamination assessment as well as physical characterization. Contamination assessment analyses provided a basis for determining nature and extent of site contamination, and physical characterization analyses aided in determining the potential bioavailability of contaminants within the source media. In addition, samples were analyzed for Target Analyte List (TAL) and Target Compound List (TCL) parameters using USEPA Contract Laboratory Program (CLP) protocols.


DISTANCE OFFSHORE (feet)
600
400
200
0
SEAWALL
30
60
30
60
30
60
30
30
N
A B C D E F G H I J K L M N O P Q R S T U
TRANSECTS
Horizontal Scale
0 200 feet
Contour Interval = 10 percent
TECHNICAL MEMORANDUM
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 2-1
PERCENT FINES IN
BOTTOM GRAB SAMPLES
SITE 2



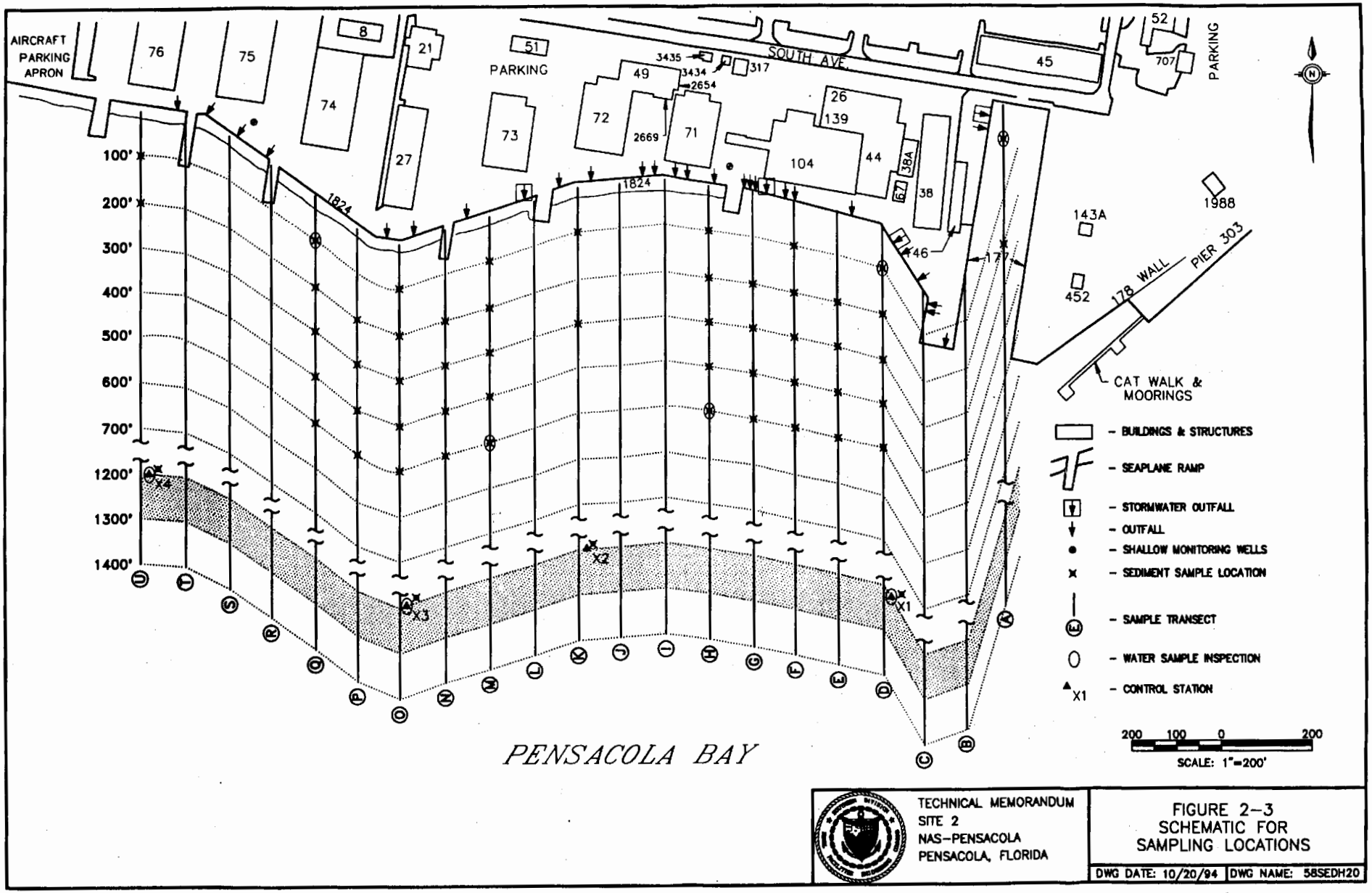
Vertical Exaggeration = 10X

Horizontal Scale

0 200 feet

TECHNICAL MEMORANDUM
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 2-2
BATHYMETRIC SURFACE
SITE 2



TECHNICAL MEMORANDUM
SITE 2
NAS–PENSACOLA
PENSACOLA, FLORIDA

FIGURE 2–3
SCHEMATIC FOR
SAMPLING LOCATIONS

DWG DATE: 10/20/94 | DWG NAME: 58SEDH20

3.0 SAMPLING PROTOCOL

Before sampling, a cadastral survey was conducted to establish a sampling baseline and transects. A 2,000-foot baseline, running east to west along the waterfront seawall, was established. At every 100-foot interval of the baseline, reference nodes with due-south trending transects, perpendicular to the baseline, were established. Offshore sampling along transects was accomplished by visually aligning shore-based pylons; distance to sampling points was determined subjectively. Generally, samples were collected at each 100-foot interval along transects which were in high probability areas (based on grain-size survey), out to about 500 feet from shore (Figure 2-3). Four control stations were placed, east to west, approximately 1,200 feet from shore. Sampling directly within the ship channel was avoided.

Water and sediment were sampled in accordance with procedures outlined in Appendices B and C, respectively, of the Sampling and Analysis Plan (SAP). Benthic invertebrate samples were collected simultaneously with sediment samples and archived for later analyses, as appropriate. The hydrologic study at Site 2 included collecting in-situ physicochemical parameters using a portable Hydrolab meter.

Sample handling adhered to the approved SAP for Site 2 and the USEPA Region IV Standard Operating Procedures/Quality Assurance Manual (SOP/QAM).

4.0 PRELIMINARY ECOLOGICAL RISK ASSESSMENT

4.1 Water Chemistry

Water samples were collected at five locations (A1, D1, H5, M5, and Q1) within Site 2, along with four from the control locations (X1, X2, X3 and X4). Inorganic, pesticide/polychlorinated biphenyls (PCB), semivolatile and volatile constituents were analyzed. Samples were collected from different depth strata (0.5 meters (m) from surface, mid-depth, and 0.5 m off bottom substrate) as appropriate.

Based on the results of the study, water quality near Site 2 does not appear to be impacted by past base practices. Table 4-1 summarizes the results of water chemistry analyses. Table 4-2 provides the in-situ physicochemical data collected.

At first glance, silver appears to be of concern across the site. The high values observed can best be explained due to a sodium matrix interference which occurs in high salinity samples. Typical Inductive Coupled Plasma (ICP) methods, as used in CLP, cannot be adjusted to remove this interference; thus, metal values will normally be erroneous. Present analytical procedures that can diminish this sodium interference include a solvent extraction procedure with dithiocarbamates (APDC and DDDC) (Bruland et al., 1979) with analysis by Graphite Furnace Atomic Absorption (GFAA) with Zeeman correction. In addition, in support of the analytical discrepancy, silver concentrations were negligible in associated sediment samples.

No pesticides, PCB congeners, or volatiles were detected above regulatory limits in any water samples. Negligible amounts of various unknown organic/semivolatile substances were found across the site but total concentrations ranged only from 100 to 200 parts per billion (ppb), which are most likely normal for the area. No other data for Pensacola Bay were available but control stations in our study did show low concentrations of semivolatile constituents, similar to those within the site proper.

4.2 Sediment Chemistry

4.2.1 Metals

Results of means and ranges for sediment metal concentrations are presented in Table 4-3. For comparison, values from other sediment studies along with "elevated" concentrations from this study are presented in Table 4-4. For this discussion, "elevated" refers to concentrations at Site 2 exceeding USEPA Region IV Sediment Screening Values (SSV).

Table 4-1
Water Chemistry Results

Contaminant	Station	Concentration in ppb	EPA AWQC[a]	FL WQS[b]
Cyanide	A101	1.0	1 ppb	1 ppb
Silver	A101	6.3		0.05 ppb
	A102	11.7		
	D1	12.1		
	H501	9.6		
	H502	10.7		
	H503	10.6		
	M501	7.4		
	M502	7.7		
	M503	10.6		
	Q1	10.1		
	X101	9.5		
	X102	9.3		
	X103	9.3		
	X301	10.6		
	X302	8.0		
	X303	10.2		
	X401	13.1		
	X402	14.4		
	X403	12.7		

Notes:

[a] = EPA-AWQC — EPA Ambient Water Quality Criteria
[b] = FL-WQS — Florida Water Quality Standards

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (μmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
A-1	11/30	1107	2.0	7.81	6.97	42639	(nd)	16.72	0.3	504
A-1	11/30			7.88	6.34	44420	(nd)	17.11	1.8	(nd)
A-2	12/1	1315	2.5	7.96	7.56	43072	28.0	17.38	0.3	417
A-2	12/1	1315		7.99	6.79	43657	28.0	17.24	1.9	412
D-1	12/1	0825	1.2	7.91	8.05	47697	31	17.70	0.6	414
D-2	11/30	1453	3.2	7.89	7.12	43903	(nd)	16.73	0.3	(nd)
D-2	11/30			7.92	6.50	46395	(nd)	17.91	3.0	356
D-3	12/1	1342	5.8	8.00	7.57	44417	28.4	17.28	0.3	411
D-3	12/1	1342		8.01	6.80	44156	28.6	17.33	2.9	411
D-3	12/1	1342		8.02	6.70	44477	28.6	17.45	5.8	411
D-4	12/6	0936	7.5	8.00	6.84	43349	28.7	16.87	0.3	421
D-4	12/6	0936		8.04	6.52	47018	31.6	18.14	3.5	(nd)
D-4	12/6	0936		8.05	5.11	42169	32.5	18.58	7.2	(nd)
D-5	12/6	0955	10.0	8.08	7.58	44640	28.8	16.83	0.3	375
D-5	12/6	0955		8.06	5.76	49279	32.2	18.55	5.0	(nd)
D-5	12/6	0955		8.07	5.8	49298	32.4	18.60	9.7	376
E2	12/1	0930	2.5	(nd)	(nd)	(nd)	(nd)	(nd)	(nd)	(nd)
E3	12/1	0950	3.5							

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
E-4	12/1	1040	9.0	7.99	6.51	46456	30.2	18.08	.3	401
E-4	12/1	1040		8.01	6.41	46973	30.9	17.98	4.5	400
E-4	12/1	1040		7.99	5.88	47204	31.4	18.47	9.0	400
E-5	12/1	1112	8.2	7.98	6.75	44156	28.8	17.36	0.3	401
E-5	12/1	1112		8.01	6.49	46269	30.1	17.76	4.0	401
E-5	12/1	1112		8.01	6.17	47678	31.2	18.20	8.2	401
F-1	11/30	1524	1.5	7.94	7.60	44489	ND	17.40	0.7	396
F-2	12/1	1432	2.3	8.01	7.43	42900	27.1	16.85	0.3	427
F-2	12/1	1432		8.03	7.00	45131	28.7	17.49	2.3	424
F-3	12/1	1500	3.5	7.99	7.34	41806	26.5	16.63	0.3	413
F-3	12/1	1500		8.00	6.09	42830	27.6	17.00	3.4	411
F-4	12/6	1128	3.5	8.07	6.20	45347	29.1	17.19	0.3	(nd)
F-4	12/6	1128		8.08	6.64	45830	29.3	17.33	3.3	361
F-5	12/6	1144	8.1	8.06	7.32	44868	29.7	17.17	0.3	(nd)
F-5	12/6	1144		8.07	6.60	45136	29.7	17.22	4.0	(nd)
G-2	12/3	0809	2.5	7.92	6.80	46484	30.1	17.53	0.3	376
G-2	12/3	0809		7.99	6.06	50105	33.4	19.04	2.2	372
G-3	12/3	0825	3.0	8.01	7.00	46364	30.3	17.58	0.3	(nd)

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
G-3	12/3	0825		8.02	6.46	47240	32.5	17.95	1.5	383
G-3	12/3	0825		8.04	6.10	50750	33.3	19.04	2.8	381
G-4	12/3	0845	3.6	8.02	7.12	46349	30.4	17.61	0.3	372
G-4	12/3	0845		8.05	6.26	50912	34.0	19.04	1.7	(nd)
G-4	12/3	0845		8.05	6.00	50590	33.8	19.06	3.3	(nd)
G-5	12/3	0915	6.5	8.03	7.08	45577	28.8	17.70	0.3	380
G-5	12/3	0915		8.06	6.14	50138	32.9	18.73	3.1	380
G-5	12/3	0915		8.06	6.16	50590	33.4	19.04	6.3	(nd)
H-1	12/2	0846	2.6	7.97	6.67	46097	30.1	17.44	0.3	386
H-1	12/2	0846		7.98	6.42	47434	31.0	18.10	2.4	384
H-2	12/2	0911	3.0	7.96	7.20	45600	29.8	17.34	0.3	388
H-2	12/2	0911		7.99	6.46	46860	30.4	17.80	1.5	(nd)
H-2	12/2	0911		8.01	6.44	46730	30.2	17.83	2.9	(nd)
H-3	12/2	0931	4.0	7.95	7.10	44120	28.7	16.85	0.3	391
H-3	12/2	0931		8.00	6.53	46026	30.6	17.66	2.0	(nd)
H-3	12/2	0931		8.01	6.47	46346	30.3	17.75	3.9	386
H-4	12/2	0957	6.2	7.96	7.20	42993	27.1	16.31	0.3	382
H-4	12/2	0957		8.01	6.69	46641	30.1	17.61	3.0	382

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
H-4	12/2	0957		8.01	6.36	46087	30.2	17.76	6.0	(nd)
H-5	12/2	1053	6.8	8.00	7.30	43916	28.5	17.05	0.3	362
H-5	12/2	1053		8.02	6.83	45505	29.7	17.42	3.4	(nd)
H-5	12/2	1053		8.03	6.65	45310	30.2	17.50	6.6	367
K-1	12/3	0932	1.4	8.04	7.34	47305	31.3	18.09	0.7	372
K-3	12/3	0948	2.7	8.03	6.92	47050	30.6	17.92	0.3	(nd)
K-3	12/3	0948		8.04	6.29	48526	31.8	18.39	2.5	380
M-1	12/3	1023	1.9	8.04	7.52	47177	30.8	18.00	0.9	363
M-2	12/3	1044	4.0	8.00	7.70	45455	29.9	17.80	0.3	361
M-2	12/3	1044		8.02	6.64	47050	30.5	17.95	2.0	(nd)
M-2	12/3	1044		8.03	6.46	46919	31.1	18.09	3.8	362
M-3	12/7	0847	6.5	8.05	7.37	40048	25.8	15.50	0.3	(nd)
M-3	12/7	0847		8.06	6.90	40959	26.7	15.51	3.0	(nd)
M-3	12/7	0847		8.04	6.54	44555	30.1	17.75	6.3	377
M-4	12/7	0910	6.5	8.05	6.95	40571	25.7	15.08	0.3	367
M-4	12/7	0910		8.06	6.96	41532	26.6	15.77	3.0	(nd)
M-4	12/7	0910		8.04	6.10	45599	28.6	16.92	6.3	(nd)
M-5	12/7	0926	6.5	8.08	7.04	40609	(nd)	15.41	0.3	(nd)

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
N-2	12/6	1319	4.0	8.01	7.52	45011	28.9	17.17	0.3	(nd)
N-2	12/6	1319		8.06	7.09	45329	29.1	17.31	2.0	(nd)
N-2	12/6	1319		8.07	7.00	45455	28.9	17.31	3.8	(nd)
N-3	12/6	1337	6.2	8.06	7.44	43856	28.7	17.07	0.3	(nd)
N-3	12/6	1337		8.09	7.27	44950	29.3	17.07	3.0	385
N-3	12/6	1337		8.08	6.76	44939	29.3	17.39	6.0	(nd)
N-4	12/6	1354	6.1	8.06	6.97	44187	28.9	17.07	0.3	395
N-5	12/6	1408	6.1	8.09	7.45	44368	28.5	17.15	0.3	396
O-1	12/7	1042	4.0	8.06	7.33	40996	26.3	15.49	0.3	(nd)
O-1	12/7	1042		8.07	7.06	41032	26.3	15.56	2.0	343
O-1	12/7	1042		8.07	6.82	41632	26.6	15.66	3.7	(nd)
O-2	12/7	1207	7.0	8.05	7.55	41026	25.8	15.72	0.3	345
O-2	12/7	1207		8.07	7.16	41300	26.6	15.52	3.5	344
O-2	12/7	1207		8.06	6.69	41964	27.1	16.11	6.8	(nd)
O-3	12/7	1224	6.9	8.07	7.44	41186	26.6	15.46	0.3	369
O-3	12/7	1224		8.07	7.58	40864	25.9	15.43	3.0	(nd)
O-3	12/7	1224		8.02	5.88	47305	30.7	18.14	6.1	369
O-4	12/7	1243	6.5	8.07	7.70	40223	26.1	15.41	0.3	376

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
O-4	12/7	1243		8.10	7.49	41106	26.3	15.65	3.2	373
O-4	12/7	1243		8.09	7.22	41982	27.2	16.00	6.3	372
O-5	12/7	1300	6.5	8.08	7.65	40153	25.9	15.45	0.3	386
O-5	12/7	1300		8.10	7.64	41941	27.1	15.60	3.0	383
O-5	12/7	1300		8.10	7.57	42123	27.4	15.85	6.3	(nd)
P-2	12/8	1243	3.5	8.15	7.79	41788	26.2	15.92	0.3	305
P-2	12/8	1243		8.11	7.62	44621	28.8	16.93	3.3	(nd)
P-3	12/8	1302	6.5	8.07	7.53	40439	26.0	15.77	0.3	357
P-3	12/8	1302		8.09	7.32	40630	26.0	15.80	3.0	(nd)
P-3	12/8	1302		8.09	6.32	49159	32.2	18.10	6.3	(nd)
P-4	12/8	1315	6.5	8.09	7.30	40995	25.4	15.79	0.3	367
P-4	12/8	1315		8.10	7.51	42300	26.3	15.74	3.0	(nd)
P-4	12/8	1315		8.10	6.86	48000	32.6	18.13	6.3	363
P-5	12/8	1328	6.6	8.11	7.04	40901	25.9	15.80	0.3	350
P-5	12/8	1328		8.12	6.77	46722	30.5	17.46	3.1	(nd)
P-5	12/8	1328		8.11	6.87	48942	32.8	18.19	6.4	346
Q-1	12/8	0812	2.0	7.79	7.72	39989	25.6	15.22	1.0	404
Q-2	12/8	0843	4.0	8.05	6.94	40168	25.6	15.30	0.3	373

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
Q-2	12/8	0843		8.07	6.57	42257	27.7	15.96	3.5	(nd)
Q-3	12/8	0900	6.1	8.08	7.26	39326	26.3	15.31	0.3	(nd)
Q-3	12/8	0900		8.08	7.07	41243	26.7	15.53	3.0	(nd)
Q-3	12/8	0900		8.06	6.37	45966	30.3	17.63	6.0	(nd)
Q-4	12/8	0925	6.0	8.09	6.79	41071	25.3	15.30	0.3	347
Q-4	12/8	0925		8.09	6.73	41670	26.3	15.85	3.0	(nd)
Q-4	12/8	0925		8.09	6.30	45660	29.4	17.04	5.8	(nd)
Q-5	12/8	0943	6.0	8.09	7.50	40165	25.6	15.33	0.3	(nd)
Q-5	12/8	0943		8.09	7.70	40860	26.2	15.48	3.0	(nd)
Q-5	12/8	0943		8.09	7.00	46353	31.2	17.46	5.8	(nd)
U-1	12/9	0857	3.1	8.12	7.54	40683	26.1	15.28	0.3	346
U-1	12/9	0857		8.13	7.59	43000	27.7	16.08	3.0	340
U-2	12/9	0918	6.4	8.09	7.22	41125	26.3	15.43	0.3	347
U-2	12/9	0918		8.11	6.56	48017	31.4	17.85	3.1	347
U-2	12/9	0918		8.12	6.08	48145	31.2	17.92	6.3	347
X-1	12/6	1026		8.04	4.94	48461	32.1	18.44	9.0	358
X-1	12/6	1026	9.5	8.06	6.12	44821	29.1	17.12	0.3	356
X-1	12/6	1026		8.07	5.60	46348	29.9	17.64	5.0	356

Table 4-2
Physico-Chemical Parameter Results in Surface Waters
Site 2

Station	Date	Time	Total Depth (m)	pH	DO (mg/l)	Cond (µmhos/cm)	Sal (ppt)	Temp (°C)	Depth (m)	Redox
X-2	12/7	0815	6.5	7.99	7.48	40114	25.6	15.15	0.3	(nd)
X-2	12/7	0815		(nd)	(nd)	(nd)	26.3	15.73	3.2	(nd)
X-3	12/8	1031	6.2	7.94	7.39	40478	25.8	15.43	0.3	382
X-3	12/8	1031		8.05	7.68	41049	26.4	15.53	3.0	(nd)
X-3	12/8	1031		8.07	6.12	48464	31.8	18.09	5.8	368
X-4	12/9	0825	6.5	8.03	7.72	40108	25.6	15.23	0.3	349
X-4	12/9	0825		8.09	7.50	41429	26.6	15.65	3.1	344
X-4	12/9	0825		8.09	6.27	47950	31.5	17.78	6.3	344

Notes:

nd = no data
DO = Dissolved Oxygen
µmhos/cm = Micromhos per centimeter
Mg/L = Milligrams per liter
ppt = Parts per thousand
cond = Conductivity

Table 4-3
Sediment Concentrations for Metals and Organics at Site 2

Parameter	Number of Sample Locations	Number of Detected Locations	Range	Mean	Control Stations' Mean Concentration
Metals (ppm)					
Arsenic	52	39	0.59 - 20.4	6.79	0.10
Cadmium	52	5	2.2 - 24	7.56	ND
Chromium	52	41	2.6 - 220	28.10	ND
Copper	52	32	2.7 - 316	35.60	ND
Lead	52	46	0.8 - 262	36.15	0.58
Nickel	52	9	6.3 - 17.5	11.40	ND
Silver	52	4	1.4 - 4.1	2.48	0.30
Zinc	52	47	1.4 - 192*	41.61	2.42
Organics (ppb)					
DDD	52	4	6.4 - 12.0	7.8	ND
DDT	52	3	5.8 - 46	20	ND
PCB (1242 & 1260)	52	2	77 - 220	149	ND
Benzo(a)anthracene	52	14	43 - 1200	360	ND
Benzo(b)fluoranthene	52	15	59 - 1700	393	ND
Benzo(k)fluoranthene	52	16	80 - 1300	402	ND
Chrysene	52	15	50 - 2000	445	ND
Fluoranthene	52	19	69 - 2600	567	ND

Table 4-3
Sediment Concentrations for Metals and Organics at Site 2

Parameter	Number of Sample Locations	Number of Detected Locations	Range	Mean	Control Stations' Mean Concentration
Anthracene	52	5	190 - 3000	846	ND
Benzo(a)pyrene	52	11	73 - 1000	395	ND
Pyrene	52	19	46-2000	460	ND

Notes:

* = A concentration of 1790 was found, but considered an outlier based on evaluation of data.
ppm = Parts per million
ppb = Parts per billion
ND = Non-Detect

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[a]
Arsenic	D3	12.4	8	A	51.3	24.2	33	13	24	23	23
	E3	20.4		A	80.0	25.5					
	F3	15.3		A	75.2	20.3					
	F4	15.4		A	75.4	20.4					
	G3	12.0		A	53.6	22.4					
	G4	16.0		A	85.1	18.8					
	H1	9.0		A	37.8	23.8					
	H2	18.0		A	85.8	21.0					
	H3	21.0		A	86.3	24.3					
	K3	16.8		B	81.7	20.6					
	N3	13.6		B	73.8	18.4					
	P2	17.3		A	84.2	20.5					
	Q2	15.4		B	80.0	19.25					
	U1	12.7		A	67.9	18.7					
Cadmium	A1	3.0	1	C	6.9		5	0.48	1.2	.17	.13
	A2	2.2		C	12.2						

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
Cadmium (cont)	D2	3.3	1	C	6.8		5	0.48	1.2	.17	.13
	H1	24.0		C	37.8	63.5					
	H5	5.3		C	7.7						
Chromium	D2	51.8	33	B	6.8		80	110	230	120	81
	D3	49.1		A	51.3	95.7					
	E3	63.6		A	80.0	79.5					
	F3	68.3		A	75.2	90.8					
	F4	50.1		A	75.4	66.4					
	G3	35.0		A	56.6	61.8					
	G4	41.0		A	85.1	48.2					
	H1	220.0		C	37.8	582.0					
	H2	70.0		A	85.8	81.6					
	H3	57.0		A	86.3	66.0					
	K3	49.7		A	81.7	60.8					
	N3	35.4		A	73.8	48.0					
	P2	43.2		A	84.2	51.3					

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
Chromium (cont.)	Q2	37.2	33	A	80.0	46.5	80	110	230	120	81
	U1	36.8		A	67.9	54.2					
Copper	A1	316.0	28	C	6.0		70	35	84	25	11
	A2	44.7		C	12.2						
	D2	38.8		C	6.8						
	D4	43.8		C	11.9						
	F3	37.1		B	75.2	49.3					
	G2	225.0		C	4.8						
	G3	58.0		C	53.6	108.2					
	H1	44.0		C	37.8	116.4					
	M1	38.0		C	2.5						
	M2	31.4		C	15.0						
Lead	A1	62.7	21	C	6.9		35	43	89	11	44
	A2	181.0		C	12.2						
	D1	89.3		C	2.2						
	D2	406.0		C	6.8						

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
Lead (cont.)	D3	49.6	21	C	51.3	96.7	35	43	89	11	44
	D4	41.9		C	11.9						
	E2	21.5		C	84.3	25.5					
	E3	39.9		C	80.0	49.9					
	F1	27.3		C	1.8						
	F2	133.0		C	4.2						
	F3	42.4		C	75.2	56.4					
	F4	40.5		C	75.4	53.7					
	G2	48.0		C	4.8						
	G3	41.0		C	53.6	76.5					
	G4	31.0		B	85.1	36.4					
	H1	262.0		C	37.8	693.1					
	H3	31.0		A	86.3	35.9					
	K3	24.4		B	81.7	29.9					
	N3	24.5		C	73.8	33.2					
	P2	26.7		A	84.2	31.7					

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
Lead (cont.)	Q2	29.1	21	B	80.0	36.4	35	43	89	11	44
	U1	31.4		B	67.9	46.2					
Zinc	A1	157.0	68	C	6.9		120	140	270	160	76
	A2	302		C	12.2						
	D2	104		C	6.8						
	D3	84.1		C	51.3	163.9					
	D4	307		C	11.9						
	E3	101		C	80.0	126.3					
	F3	109		C	75.2	144.9					
	H1	192.0		C	37.8	507.9					
	H2	120.0		B	85.8	139.9					
	H3	74.0		A	86.3	85.7					
	Q2	1790		C	80.0	2237.5					
DDT	A1	5.8	3.3	NA	6.9		1				
	A2	7.9		NA	12.9						
	H1	12.0		NA	37.8	31.7					

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
DDT (cont.)	M2	46.0	3.3	NA	15.0		1				
tDDT	A1	12.2	3.3	NA	6.9		3	6.6	37	nd	6.4
	A2	14.3		NA	12.2						
	F2	6.5		NA	4.2						
tPCB	A2	77.0	33	NA	6.9		50	39	200	17	59
	H1	220.0		NA	37.8	582.0					
tPAH	A2	5200	2900	NA	12.2		4000			1700	1000
	D2	15800		NA	6.8						
	D3	1980		NA	51.3	3860					
	E3	2010		NA	80.0	2513					
	D4	2610		NA	13.4						
	E5	3377		NA	7.0						
	F3	3700		NA	75.2	4920					
	F4	1970		NA	75.4	2613					
	G4	9700		NA	85.1	11398					
	H1	3330		NA	37.8	8809					

Table 4-4
Comparison of Elevated Sediment Contaminant Concentrations at Site 2 to Other Studies

Contaminant[d]	Station	Concentration	EPA Region IV Screening Values	Concentration Compared to FDEP Regressions[e]	% Silt & Clay	Conc. Normalized to % Silt & Clay[f]	Long & Morgan ERL	NOAA NS&T[a]		NOAA, NS&T Pensacola Bay	
								Mean	"High"	PEN[b]	PBIB[c]
tPAH (cont.)	H3	2110	2900	NA	86.3	2445	4000			1700	1000
	N3	1600		NA	73.8	2168					

Notes:

[a] = National Status & Trends Program; 1991.
[b] = Pensacola Bay Proper
[c] = Pensacola Bay - Indian Bayou
[d] = Concentration for metals in ppm; all others in ppb.
[e] = Study sponsored by formerly titled Florida Dept. Environmental Regulation (FDER); present title Florida Dept. Environment Protection (FDEP).
[f] = When silt & clay was <20%, concentrations were not normalized.

For FDEP Comparison:

A = Detected concentration was above USEPA Region IV Screening Value but within FDER 95 percent confidence interval for metal to aluminum ratio.
B = Detected concentration was above USEPA Region IV screening value and just above 95 percent confidence interval for metal to aluminum ratios; but considered "normal" due to conservative analytical methods.
C = Detected concentration was above Region IV Screening Value and well above FDER metal-to-aluminum ratio.
NA = Not Applicable for organics.
ERL = Effects Range Low
NOAA = National Oceanic and Atmospheric Administration

To best determine if concentrations found are of ecological significance, several assessment methods must be discussed. As previously mentioned, Site 2 values were labeled as "elevated" based on SSVs established by Region IV. This term should not imply that concentrations exceeding the SSV indicate environmental injury or impact. Physicochemical conditions and natural variability act as mediators to biotic impacts from sediment-borne metal concentrations. It is better to assess as many variables as feasible to determine potential biotic impact from a metal's availability.

The following paragraphs discuss the relevance of several studies that have been used to compare Site 2 metal concentrations.

USEPA Region IV SSVs

USEPA Region IV SSVs provide a good starting point for comparison. SSVs were proposed after review of three studies (Long & Morgan 1991, MacDonald 1993, and Long et al., in press) that evaluated effects-based concentrations. Without specific knowledge of USEPA's approach, it appears that SSVs were selected based on the lowest effects value from one of these studies, or placed at the CLP Practical Quantitation Limit (PQL). There are several drawbacks to using this approach for assessing metals at Site 2. First, none of the studies used accounted for grain-size effects; secondly, natural metal concentrations in sediments were not considered for the effects levels generated; and third, other physicochemical effects were not used to assess the effects levels proposed. Considering the dynamic nature of present sediment effects studies, this appears as a good starting point as any other for assessing metal contaminants.

FDEP Metal-to-Aluminum Ratios

To address the natural concentration of metals in sediments, concentrations found at Site 2 were compared to metal-to-aluminum ratios as discussed in Florida Department of Environmental Regulation (FDER, now FDEP) (1988). To summarize FDER's approach, regional natural metal to aluminum ratios exist, anthropogenic input to areas can be assessed by comparing metal

concentrations to those ratios. FDER produced regression lines which were determined from "clean" sites in Florida, along with 95 percent prediction limits. The extent of the metal concentration above the prediction limit should indicate the likelihood of metal-enrichment. FDER (1988) strongly insists that full sediment digestion be included in the analytical procedures, this will allow true metal:aluminum ratios to be calculated. The Site 2 sediment digestion procedures were not the same as those used by FDER (1988); instead typical CLP methods were employed. Based on conversation with Tom Seale (FDEP; 4-20-94), the digestion procedures used for Site 2 would reveal conservative values for metals when plotted against established regression lines. For this reason, we believed comparison to FDER's ratios were relevant and most conservative.

NOAA NS&T

It is well established that contaminants have an affinity for fine-grained sediments. As a result, grain size distribution in sediments can be used to predict potential contaminant distribution and relative concentrations (i.e. fine-grained sediments should have higher contaminant concentrations than coarse-grained sediments). The National Oceanic and Atmospheric Administration (NOAA)'s National Status & Trends (NS&T) Program (1991) uses this approach; therefore, its national database has been normalized for grain size. In sediments which have 20 percent or greater composition of fine- grained particles (diameter $< 63\mu$), raw concentrations are divided by the fraction-by-weight of fines. When the fine-grained sediment percentage was less than 20 percent, analytical concentrations measured are used as real numbers. To compare raw values at Site 2 to the NS&T database, (includes National, Pensacola Bay-Proper and Pensacola-Indian Bayou values) concentrations were normalized to fine-grained sediment percentages. Our approach to normalizing concentrations was to compare Site 2 data to nationally represented concentrations. It must be mentioned, as did NS&T, that these concentrations are not an indication of biological effects. NS&T also provides that, "comparison of their 'high' values to Long and Morgan (1990) effects concentrations indicates that

concentrations need to be higher than simply in the 'high' range before biological consequences are likely."

Long and Morgan

Long and Morgan's (1990) analysis of effects level concentrations has long been used to preliminarily assess sediment-borne contaminants. It is understood that their database included freshwater sites and that effect may not be completely applicable to Site 2, but, it was thought that for comparison their data were useful. Again, it is important to consider that effects level concentrations proposed by Long and Morgan (and also in Long et al. in press) do not account for grain-size effects. Thus threshold levels indicated by the studies may be considered raw concentration effects values and could possibly be higher if grain size had been considered.

Arsenic

Arsenic was detected at 39 of the 52 (75%) sample locations. Concentrations ranged from 0.39 to 20.4 parts per million (ppm) with a arithmetic mean of 6.79 ppm (Table 4-3). The mean was less than the SSV (8.0 ppm), but 14 locations had values above the SSV. Sandy control stations did not exhibit any arsenic concentrations above the SSV.

Arsenic has been suggested by NS&T (1991) to be high in Pensacola Bay. But, when raw concentrations from Site 2 were plotted on the FDER regression line, all of the values appeared to consistent with natural concentrations of arsenic in Florida sediments (Table 4-4). Also, all raw values were much lower than Long and Morgan's "effects range low" (ERL) value. Normalized concentrations were higher than mean NS&T values but similar to the "high" concentration and close to both values observed in Pensacola Bay. Concentrations at the control stations ranged from non-detect (ND) to 0.39 ppm.

Spatially, higher concentrations were found in the northeast portion of the site. These "elevated" concentrations were found in shallower areas having higher percentages of fines.

Even though arsenic levels may indicate an anthropogenic input, they may not necessarily be indicative of ecological impact. Normalized concentrations are not high enough to warrant any continued investigation.

Cadmium

Cadmium was found at five of the 52 (9.6%) locations sampled and all concentrations (range 2.2 to 24 ppm; mean 7.56 ppm) were above the SSV. One location (H1) had a value of 24 ppm, which skewed the mean up from 2.3 ppm for the other four locations (Table 4-4). Most of the values were below the Long & Morgan ERL value but above the NS&T National and Pensacola levels. Observed concentrations appear to be anthropogenic in nature; well above the 95 percent prediction limit for the element.

Sandy control stations did not exhibit any cadmium concentrations above the SSV. Spatially, all but one of the locations observed were close to shore (100 foot transect) and thus are most likely subjected to frequent input from stormwater runoff.

Cadmium levels do not appear to be ecologically significant at Site 2 area based on the concentrations observed. Distribution across Site 2 is sparse and inconsistent and no source is obvious. Later discussion will address the high concentration found at location H1.

Chromium

Chromium was found at 41 of 52 locations with a range of 2.6 to 220 ppm and mean of 28.1 ppm. The mean concentration observed was below USEPA's suggested SSV. "Elevated" concentrations were found at 15 of these 41 locations. All of the "elevated" concentrations except one (H1) appeared to be natural for Florida sediments. Normalized values were similar to Long & Morgan's ERL and below NS&T national numbers, and comparable or below Pensacola values. Sandy control locations had non-detect chromium concentrations.

Chromium correlated highly with shallow water and fine-grained substrates. Most "elevated" chromium was found in the northeast portion of the site.

Based on these findings, chromium contamination across the site should not be an issue. Although past practices have indicated chromium as a potential problem, the data indicated otherwise.

Copper

Copper was found at 32 of 52 (61%) locations. Concentrations ranged from 2.7 to 316 ppm and the mean value was 35.6 ppm. The mean value exceeded the SSV but fell below the Long & Morgan ERL. All but one of the 10 "elevated" concentrations fell above the FDER 95 percent prediction limit indicating anthropogenic input. Overall, "elevated" concentrations were comparable to the NS&T National mean, lower than the National "high," but above both Pensacola Bay values.

For unknown reasons copper concentrations were "elevated" more frequently in the sandy substrate than in areas of fine-grained sediment. "Elevated" concentrations were found at closer, in-shore locations.

Although copper in Site 2 sediment appears to be above normal concentrations (control stations were all non-detect), these concentrations do not justify considering it as a significant site contaminant.

Lead

Lead was found at 46 of the 52 (88%) locations across Site 2. Concentrations ranged from 0.8 to 262 ppm and the mean was 36.2 ppm. "Elevated" concentrations were observed at 22 locations and five of these were above the NS&T "high." When plotted against the FDEP Regression approximately 70 percent of these "elevated" concentrations were considered

anthropogenic in nature. About half are near the Pensacola Bay-Indian Bayou concentration, but most are well above the Pensacola Bay proper concentration.

Spatially, the higher concentrations are in the eastern portion of the site with more natural ones found to the west. As with copper, obvious lead inputs to sediment at Site 2 have occurred. Only a few locations have concentrations that are significant.

Lead does not appear to be at acutely injurious concentrations based on site-wide distributions. Increased bioavailability and occurrence of lead-sensitive species within the area would magnify its potential chronic risk.

Zinc

Zinc was found at 47 of 52 (90%) locations. Concentrations ranged from 1.4 to 192.0 ppm, with a mean of 41.6 ppm. One concentration of 1790 ppm was found at location Q2, no explanation for this high concentration was found and it was not included in the mean calculation. The mean was well below the SSV but nine of the 11 "elevated" locations appeared to be anthropogenically influenced (per FDEP Regression). The majority of the concentrations were comparable to the NS&T National mean and the Pensacola Bay Proper value. "Elevated" zinc concentrations were found most often in the northeast portion of the site.

Zinc concentrations observed do not appear to be critical to biota inhabiting the area. Sediment geochemistry, along with physicochemical factors (aerobic environment with pH > 7) in overlying water likely reduce zinc's potential bioavailability.

4.2.2 Organics

Polycyclic Aromatic Hydrocarbons

Discussion of polycyclic aromatic hydrocarbons (PAHs) refers to both low and high molecular weight compounds and will be considered as total PAH (tPAH). Although environmental impacts differ considerably between the two groups, the variability in the specific compounds found between locations would make discussion difficult. When critical concentrations for specific compounds were noticed at individual locations, they were discussed separately.

For our discussion, concentrations were considered "elevated" when tPAH concentrations were greater than 2000 ppb (either raw or normalized number). Although the SSV for tPAH is 2900 ppb, a more conservative value was determined to be more appropriate for comparison because of the variability in specific compounds detected between samples.

PAHs were found at 25 (48%) locations across the site, 12 of which had "elevated" concentrations (Table 4-4), and seven which exceeded the SSV. "Elevated" concentrations ranged from 2,168 to 15,800 ppb. Concentrations at five locations exceeded the Long & Morgan ERL, and almost all of the "elevated" locations were above concentrations for both NS&T Pensacola Bay stations.

PAHs were found primarily in the northeast portion of the site. As mentioned previously, this area receives considerable input from storm water runoff. Additionally, this area includes the boat slip for port operations, which houses several boats. Boat maintenance is also performed in this area. It is not surprising that PAH concentrations are high in these sediments. Most PAHs were detected in shallow to mid-depth areas and were associated with fine-grained sediments.

The most common PAH compounds detected in substantial amounts included anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, pyrene, benzo(k)fluoranthene,

chrysene, and fluoranthene. Most of these are four- to five-ring compounds which tend to remain longer in sediments. About half of these are considered to be mammalian carcinogenic, tumorigenic or co-carcinogenic.

Total PAH concentrations in certain portions of Site 2 appear significant. It is suspected that the concentrations observed in the northeast area are a result of the frequent vessel use and maintenance. Also, discharge from storm water runoff most likely contributes to the higher concentrations observed in that area.

Volatiles

Volatiles concentrations in sediment samples were negligible. No significant individual compound was noticed and no markedly high values were observed. No further discussion on volatile concentrations is warranted.

Pesticides/PCBs

Pesticides and PCBs were found at a very limited number of locations across the site (Table 4-3). Pesticide concentrations were all above the SSV and Long & Morgan ERL value but comparable to NS&T's "high" value (Table 4-4). Only two PCB congeners were found, and like pesticides, their concentrations were above the SSV and Long & Morgan's ERL, but below or comparable to NS&T's "high" value.

Pesticides and PCBs were both found at locations A2 and H1 (along with PAHs). These areas are suspected to be influenced by proximal discharge culverts or pipes into the bay.

4.3 Conclusions

Sampling methods and techniques employed at Site 2 were sufficient for characterizing contamination across the site.

Surface water chemistry results indicate that no contaminants are of concern to receptor organisms in the area via this media. Metals and organic concentrations are negligible across the site.

Sediment chemistry results show elevated concentrations of cadmium, copper, lead and zinc. Cadmium concentrations were significant but not widely distributed. Copper was found at concentrations suggesting anthropogenic input, but not high enough to indicate that significant effects are occurring. Lead was found at most locations, and a majority of these were considered anthropogenic. Generally, lead concentrations could be affecting local biota, but this would be difficult to determine. Zinc is higher and more widely distributed than would normally be expected but physicochemical factors affecting bioavailability should limit its effect at the site.

PAHs appear to be the most significant organic contaminants found at the site. The concentrations observed for the most critical compounds suggest biological impacts could occur. It must be noted that PAHs at Site 2 can not be directly related to a source.

Spatial distributions of both metal and organics were concentrated in the northeast portion of the site. These distributions may be partially attributed to the area's hydrodynamic regime. Incoming tides tend to be swirled, or restricted, in the area just west of the docking pier, thus inhibiting long-shore sediment transfer. Major outgoing tidal vectors are deflected away from this area, resulting in a low energy regime. This hydrodynamic regime allows the deposition of fine-grained sediment.

Sampling in the "high priority" selected areas, as determined during the sediment assessment phase, revealed "elevated" concentrations almost exclusively to the east of Transect K. These "elevated" contaminant concentrations were associated with the fine-grained sediments and shallow (<2.5 meters [m]) to moderate (2.5 m to 6.0 m) water depths.

Based on the information collected during this study, it is difficult to determine if contaminants can be attributed to past disposal practices from shore-based facilities or are a result of more recent influxes. Ecological impacts resulting from contamination concentrations observed do not appear to be critical. Continuation of subsequent phases of the RI process would not reveal significant information toward this objective. It is recommended that further work to quantify ecological impacts is not warranted at Site 2.

5.0 PRELIMINARY HEALTH RISK ASSESSMENT

5.1 Introduction

The human health risk/hazard often is used to gauge the need for remedial actions. The purpose of this Preliminary Health Risk Assessment (PHRA) is to describe the process by which preliminary risk/hazard numbers were generated, present the risk/hazard of Site 2 as indicated by these calculations including a discussion of the uncertainty involved, and to draw conclusions or make recommendations based on this risk information. This section, which loosely follows the example presentation outline in Risk Assessment Guidance for Superfund (RAGS), is not intended to serve as a substitute for a BRA as required for the RI.

The PHRA considers environmental media and exposure pathways that could result in unacceptable levels of exposure now or in the foreseeable future. The PHRA's value as a basis for making remedial decisions is contingent upon an adequate characterization of site chemical contamination. Variables considered in characterizing the site and its associated risk are the amount, type, and location of contaminant sources; the pathways of exposure (media type and migration routes); and the type, sensitivities, exposure duration and dynamics of the exposed populations (receptors). The RI, presently being conducted by EnSafe/Allen & Hoshall (E/A&H), provided the site characterization data used in this assessment. As part of the RI, the BRA will be prepared in accordance with the guidelines set forth in:

Risk Assessment Guidance for Superfund, ***Volume I-Human Health Evaluation Manual, Parts A & B,*** *USEPA/OERR, EPA/540/1-89/002, December 1989 and EPA/540/R92/003, December 1991 (Interim). (RAGS, Parts A & B).*

Risk Assessment Guidance for Superfund, ***Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final,*** *USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991.*

Risk Assessment Guidance for Superfund, ***Volume II-Environmental Evaluation Manual,*** *Interim Final, USEPA/OERR, EPA/540/1-89/001, March, 1989.*

Supplemental Region IV Risk Assessment Guidance (March 26, 1991).

Draft Supplemental Guidance to RAGS: ***New Interim Region IV Guidance*** *(February 11, 1992).*

A PHRA is used to evaluate potential threats to human health and the environment from hazardous substances and provides an initial evaluation in support of subsequent BRA activities. A BRA is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) to provide for remedial action at National Priorities List (NPL) sites that is protective of human health and the environment. The remedial process, which includes the definition of risk assessment, is described in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and USEPA guidance. Specific guidance on conducting a BRA, including a full quantitative risk assessment for likely exposure pathways, also is provided in USEPA documents referenced above.

5.2 Identification of Chemicals of Potential Concern

Before embarking upon an evaluation of potential risk/hazard posed by a site, the nature and extent of contamination must be thoroughly analyzed. The first and most basic data analysis involves qualitative assessment. Simply stated, is the compound/parameter present? From this assessment, the list of possible site contaminants will be narrowed to include detected compounds.

The analysis of Site 2 surface water and sediment (all parameters detected) was used to develop the Chemicals of Potential Concern (COPCs) list in this PHRA. The minimum, maximum, and mean concentrations detected were compared to the USEPA Region III Screening Concentrations, First Quarter 1994, version. The concentrations detected were then compared to sediment screening concentrations provided by USEPA Region IV and screening concentrations for the tissue ingestion exposure pathway provided by USEPA Region III. For screening purposes, it was assumed that the sediment concentration was equivalent to the tissue concentration. A summary of sediment concentrations detected is shown in Table 5-1, and as shown in Table 5-2, the following compounds exceeded the Region III screening concentrations for tissue ingestion at the minimum concentration detected onsite: arsenic, cadmium, PCBs 1242 and 1260, benzo(a)anthracene, benzo(b&k)fluoranthene, and benzo(a)pyrene. Although arsenic and cadmium would be expected to be elevated in some crustaceans, these parameters have been retained for this memorandum. Additional comparisons were made in preceding sections of this memorandum.

5.3 Exposure Assessment

The objectives of an exposure assessment are to characterize the potentially exposed populations, identify actual or potential exposure pathways, and to determine (and quantify, if possible) the extent of exposure. For exposure to occur, four essential elements must exist, i.e. (1) a source and mechanisms of chemical release to the environment, (2) an environmental transport medium (e.g., air-, groundwater-released chemical), (3) a point of potential contact (indirect exposure point) with the contaminated medium defined in terms of a potential dose or availability, and (4) an exposure route (e.g., inhalation, ingestion) at the contact point.

Previous studies have described the bay sediments to be fine sands to a water depth of 30 feet and silty sands and muds from that depth to the deepest parts of the ship channel (E&E, 1992a). However, few sediment samples had been collected in the Site's immediate area. Due to the

Table 5-1
Maximum, Minimum, and Mean Sediment Concentrations
NAS Pensacola, Site 2
Pensacola, Florida

Parameters	Maximum (mg/kg)	Minimum (mg/kg)	Mean (mg/kg)
Inorganics			
Arsenic	20.4	0.59	6.79
Cadmium	24.0	2.2	7.56
Chromium	220.0	2.6	28.1
Copper	316.0	2.7	35.6
Lead	262.0	0.8	36.15
Nickel	17.5	6.3	11.4
Silver	4.1	1.4	2.48
Zinc	182.0	1.4	41.6
Organics			
DDD	0.012	0.0054	0.0078
DDT	0.046	0.0059	0.020
PCB (1242 & 1260)	0.22	0.077	0.149
Benzo(a)anthracene	1.2	0.043	0.360
Benzo(b)fluoranthene	1.7	0.06	0.393
Benzo(k)fluoranthene	1.3	0.08	0.402
Chrysene	2.0	0.05	0.445
Fluoranthene	2.6	0.069	0.567
Anthracene	3.0	0.19	0.546
Benzo(a)pyrene	1.0	0.073	0.395
Pyrene	2.0	0.046	0.460

Note:

mg/kg = milligram per kilogram

Table 5-2
Comparison of Site 2 Sediment Concentrations to USEPA Region III
Screening Concentrations for Fish Consumption and Sediment Screening Concentrations
and Comparison to USEPA Region IV Sediment Screening Values
NAS Pensacola, Site 2
Pensacola, Florida

Parameter	NOAA ER-L (mg/kg)	NOAA ER-M (mg/kg)	Exceedances			USEPA Region III Screening Concentrations (mg/kg tissue) for Fish Consumption	Exceedances
			@ Min	@ Mean	@ Max		
Inorganics							
Arsenic	33	85	None	None	None	0.41 n	D
Cadmium	5	9	None	ER-L	ER-M	0.68 n	D
Chromium	80	145	None	None	ER-M	6.8 n	X
Copper	70	390	None	None	ER-L	50.0 n	M
Lead	35	110	None	ER-L	ER-M	NA	NA
Nickel	30	50	None	None	None	27.0 n	None
Silver	1	2.2	ER-L	ER-M	ER-M	6.8 n	None
Zinc	120	270	None	None	ER-L	410.0 n	None
Organics							
DDD	0.002	0.02	ER-L	ER-L	ER-L	0.013 c	None
DDT	0.002	0.015	ER-L	ER-M	ER-M	0.009 c	X
PCB (1242 & 1260)	0.05	0.4	ER-L	ER-L	ER-L	0.00041 c	D
Benzo(a)anthracene	0.23	1.6	None	ER-L	ER-L	0.0043 c	D

Table 5-2
Comparison of Site 2 Sediment Concentrations to USEPA Region III Screening Concentrations for Fish Consumption and Sediment Screening Concentrations and Comparison to USEPA Region IV Sediment Screening Values
NAS Pensacola, Site 2
Pensacola, Florida

Parameter	NOAA ER-L (mg/kg)	NOAA ER-M (mg/kg)	Exceedances @ Min	Exceedances @ Mean	Exceedances @ Max	USEPA Region III Screening Concentrations (mg/kg tissue) for Fish Consumption	Exceedances
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	0.0043 c	D
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	0.0043 c	D
Chrysene	0.4	2.8	None	ER-L	ER-L	0.43 c	X
Fluoranthene	0.6	3.6	None	None	ER-L	54.0 n	None
Anthracene	0.085	0.96	ER-L	ER-L	ER-M	410.0 n	None
Benzo(a)pyrene	0.4	2.5	None	None	ER-L	0.00043 c	D
Pyrene	0.35	2.2	None	ER-L	ER-L	41.0 n	None

Notes:

D = Denotes minimum concentration exceeds the screening value.
X = Denotes mean concentration exceeds the screening value.
M = Denotes maximum concentration exceeds the screening value.
c = Indicates risk-based screening concentration.
nc = Indicates hazard-based screening concentration.

— Comparison made to USEPA Region III risk screening concentrations for fish tissue consumption assuming equal concentrations in fish and sediment.
— Table 5-2 was established based on the assumption that sediment concentrations and tissue concentrations are equal for screening purposes.
— See Table 5-1 for sediment concentrations detected at Site 2.

activities in Building 71 and the potential for contamination at Site 2, sediment sampling was undertaken as part of the Site 2 RI/FS.

5.3.1 Exposure Pathways

The sole pathway addressed in this PHRA is ingestion of potentially contaminated shellfish. Additional pathways may be addressed in the RI, or others may be deleted from the list of pathways addressed. Table 5-3 describes the pathways selected for risk analysis in this preliminary assessment.

Direct Surface Water and Sediment Pathways

Incidental ingestion and dermal contact with surface water and sediment at NAS Pensacola Site 2 would best be addressed assuming a recreational exposure scenario for potential current and future receptors. Incidental ingestion of surface water while swimming was assumed to be a conservative estimate of potential risk/hazard at Site 2. Based on the findings discussed in Section 4 of this memorandum, surface water does not appear to be impacted by past or present activities at Site 2, and that exposure pathway need not be addressed. As noted in Table 5-3, this exposure pathway may be retained and addressed as part of the RI BRA. Dermal contact and incidental ingestion of Site 2 sediment is not expected to be a probable source of chronic exposure under current or future conditions. However, this exposure pathway could be addressed as part of the Site 2 BRA in the RI Report if chronic exposure is confirmed.

Table 5-3
Current/Future Potential Pathways of Human Exposure, Naval Air Station, Site 2, NAS Pensacola
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Route	Pathway Selected for Evaluation	Reason for Selection or Exclusion
Current and Future Site/Area Residents/ Recreationists	Air, inhalation of gaseous contaminants	No	Lack of direct exposure pathway. This exposure scenario would not be a concern at Site 2.

Table 5-3
Current/Future Potential Pathways of Human Exposure, Naval Air Station, Site 2, NAS Pensacola
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Route	Pathway Selected for Evaluation	Reason for Selection or Exclusion
Current and Future Site/Area Residents/ Recreationists (Continued)	Air, inhalation of particulate-bound contaminants	No	Lack of direct exposure pathway. This exposure scenario would not be a concern at Site 2.
	Groundwater, inhalation of volatile contaminants	No	Lack of direct exposure pathway. This exposure scenario would not be a concern at Site 2.
	Groundwater, ingestion and dermal contact with contaminants in medium from potable sources or general domestic use	No	No potable wells onsite. Lack of direct exposure pathway. This exposure scenario would not be a concern at Site 2.
	Soil, incidental ingestion of and dermal contact with (absorption) of soil contaminants onsite	No	No soils present onsite.
	Sediment, incidental ingestion and dermal contact (absorption) of contaminants while swimming	No (Qualified)	The potential (future use) exists for exposure to sediments on occasion under a recreational scenario; this exposure pathway could be addressed in the BRA as part of the RI.
	Surface water, ingestion and dermal contact (absorption) of contaminants while swimming	No (Qualified)	The potential (future use) exists for exposure to surface water on occasion under a recreational scenario. This medium was not determined to be impacted by Site 2 activities (see Section 4.0 of this document).
	Surface water, ingestion and dermal contact (absorption) of contaminants during potable or general domestic usage	No	Other sources of potable water are readily available, and the high total dissolved solids and salinity would prevent direct potable water use.
	Fish and shellfish, ingestion of species obtained from surface water bodies surrounding the site	Yes	This exposure scenario will be retained. The ingestion of fish will be addressed herein.
	Wild game or domestic animals, ingestion of species indigenous to the area which have contacted/ingested contaminated media onsite	No	This exposure scenario will not be retained. The ingestion of shellfish such as blue crabs is addressed as part of the scenario above.
	Fruits and vegetables, ingestion of plant products grown in potentially contaminated media	No	Lack of direct exposure pathway. This exposure scenario would not be a concern at Site 2.

Ingestion of Shellfish

Shellfish ingestion was addressed to screen potential bioaccumulation in edible tissue and subsequent ingestion by potentially exposed individuals. A conservative model was selected to address this issue, the Thermodynamic Bioaccumulation Potential (TBP). TBP is used as a screen by the U.S. Army Corps of Engineers (USACE) to predict the bioaccumulation of contaminants from potential dredge sediments. As in the tiered testing performed by USACE, risk and hazard threshold exceedances based on concentrations predicted by this model (a screen) indicate only that further investigation is warranted. This model does not substitute for tissue analysis, nor does it serve as a substitute for Site 2 validated biological accumulation factors.

The TBP model is based on the assumption that the concentration in sediment can be used to determine the tissue concentration at a steady state where excretion/elimination is not considered. In other words, in an environment that doesn't change, an organism would accumulate a certain amount of a contaminant if conditions remain undisturbed and sediment TOC, amount of contaminant available, and organism percent lipid also remain unchanged. This model was developed using contaminants such as PCBs, which are known to readily bioaccumulate in the lipid portion of tissues. Many contaminants, such as PAHs, do not accumulate as readily in many organisms as the contaminants used to develop the model; however, PAHs were included in the Site 2 assessment.

As part of the research on the TBP model, it was experimentally determined that TOC in sediment relates to the percent lipid in an organism by an accumulation or preference factor. The concentrations predicted by the TBP model are also extremely conservative in that the model does not consider percent area affected, water column dilution, and differential sediment binding sites. This is discussed in the Uncertainty Section of this PHRA. The accumulation factor used in the model was adjusted to be more conservative by USEPA.

5.3.2 Quantification of Exposure

The Chronic Daily Intake (CDI) is a calculated estimate of intake of each COPC and is subsequently used to estimate risk. The exposure assumptions used in calculating the CDI may be modified in the RI in cases where site-specific exposure information is applicable. For example, if an exposed individual is known to ingest 5 pounds of fish (harvested onsite) over two weeks, then this information can be used to adjust the ingestion rate and exposure duration for that exposure pathway accordingly, resulting in less uncertainty in the CDI and the subsequent risk estimates. In this PHRA, CDI for potential childhood exposure was calculated separately.

In order to calculate CDI for the tissue ingestion exposure pathway, TBP must first be calculated for all applicable organic compounds. This calculation is performed thus:

$$TBP = p(Cs/TOC)(Lp)$$

Where

TBP	=	*thermodynamic bioaccumulation potential in milligram per kilogram (mg/kg)*
p	=	*preference or accumulation factor (4.0, USEPA, 1990)*
Cs	=	*sediment concentration (mg/kg)*
TOC	=	*total organic carbon in sediment (%)*
Lp	=	*percent lipid in edible tissue (1.5%, Callinctes sapidus)*

As shown above, TBP is a simple calculation for bioaccumulation and can be used as a simple screen for resultant risk/hazard. The indicator species, *Callinectes sapidus* (blue crab), is one which could potentially accumulate more PAHs than other organisms, is relatively stationary, and is harvested and ingested by man. The blue crab is a benthic macroinvertebrate, is potentially preyed upon by other species, and lacks the enzymes necessary to metabolize PAHs and prevent bioaccumulation. Because this scavenger species resides on rocks and sediment, the potential for chronic exposure to sediment constituents exists. The analysis of this middle trophic level organism facilitates assessing bioconcentration up the food chain.

The percent lipid for blue crabs (1.5% edible portion) was obtained from a letter written by Martin Arhelger of Espey, Huston & Associates, Inc. The maximum percent lipid value was selected to maintain conservatism in the model and to account for potential sex/seasonal lipid fluctuations. Contaminant-specific TOC values were used in the TBP calculation (i.e., the mean TOC from only locations where the individual COPCs were detected). Based on the concentrations predicted by the model, CDI for the tissue ingestion exposure pathway was calculated based on the assumptions and formula shown below.

$$CDI = \frac{Ct \times EF \times ED \times IRt \times 0.001\ kg/g}{(BW \times AT)}$$

Where

CDI	=	*chronic daily intake of a COPC (mg/kg/day)*	*chemical-specific*
Ct	=	*tissue concentration (mg/kg)*	*based on TBP*
EF	=	*exposure frequency (days/yr)*	104_{adult} 196_{child}
ED	=	*exposure duration (yr)*	*24 years (adult)* *6 years (child)* *30 years (total)*
IRt	=	*ingestion rate of tissue (g/day)*	*54 g tissue/day*
0.001 kg/mg	=	*conversion factor*	*unit conversion factor*
BW	=	*body weight (kg)*	*70 kg (adult)* *15 kg (child)*
AT	=	*averaging time (days)*	$25550_{carcinogen}$ *days* $8760_{noncarcinogen\ (adult)}$ *days* $2190_{noncarcinogen\ (child)}$ *days*

Some explanation of the assumptions above is necessary. The exposure frequency is assumed to be all weekends in a year, which includes summer vacation for children. Although blue crabs are known to spawn for a portion of the year, this was not factored into the equation, and as a result, the assessment is more conservative. Other assumptions were obtained from RAGS. Again, due to the assumptions made in the model, any resulting risk/hazard exceeding the standard USEPA point of departure or unity threshold indicates the need for further investigation and possibly tissue analysis. TBP was used to estimate the bioaccumulation potential for the organic COPCs identified in the previous screening effort. In addition, Site 2 sediment concentrations were compared to USEPA Region III Screening concentrations for tissue

ingestion, assuming sediment concentrations are equivalent to tissue concentrations. The sediment concentrations detected and tissue concentrations predicted by the TBP model are presented in Table 5-2 (previously presented) and Table 5-4, respectively. TOC concentrations have been previously presented in Section 4 of this memorandum, and the TOC was location specific. Wherever potential contaminants were positively detected, the TOC for those locations was used to calculate a mean TOC for that contaminant. The tissue concentrations predicted by TBP were used to determine CDI for the tissue ingestion exposure pathway. The CDI results are shown in Table 5-5.

5.4 Toxicity Assessment

The toxicity assessment's objective is to further determine the potential hazard posed by the COPCs for which exposure pathways have been identified. The USEPA has developed toxicological databases providing information on common environmental media contaminants identified at hazardous waste sites. The primary information source (database) used for this purpose is the Integrated Risk Information System (IRIS). If toxicological information for a particular contaminant is not available in IRIS, USEPA's Health Effects Assessment Summary Tables (HEAST) serves as a secondary reference. The Fiscal Year 1992 HEAST was used to derive toxicological data for these PHRAs. In the absence of IRIS or HEAST entries on a particular chemical, the risk assessor pursues other avenues for evaluating the health effects or ecological significance of contaminant concentrations. Surrogate and provisional information is sometimes available from USEPA's Environmental Criteria and Assessment Office (ECAO) in Cincinnati, Ohio, which retains information on myriad chemical compounds to supplement primary reference information. In addition, surrogate risk information is used based on similar chemical structure. A general overview of information available in IRIS and HEAST is provided below, along with a discussion of applicability.

Table 5-4
Thermodynamic Bioaccumulation Potential (TBP) of Sediment Concentrations into Blue Crab Tissues and Comparison to USEPA Region III Screening Concentrations for Fish Consumption
NAS Pensacola, Site 2
Pensacola, Florida

Parameter	TBP Predicted Concentrations			USEPA Region III Screening Concentrations for Fish Consumption (mg/kg tissue)	Exceedances of USEPA Region III Screening Concentrations for Fish Consumption
	@ Max (mg/kg tissue)	@ Min (mg/kg tissue)	@ Mean (mg/kg tissue)		
DDD	1.200	0.540	0.780	0.013 c	D
DDT	6.900	0.885	3.000	0.009 c	D
PCB (1242 & 1260)	16.500	5.775	11.175	0.00041 c	D
Benzo(a)anthracene	72.000	2.580	21.600	0.0043 c	D
Benzo(b)fluoranthene	102.000	3.540	23.580	0.0043 c	D
Benzo(k)fluoranthene	60.000	3.692	18.554	0.0043 c	D
Chrysene	109.091	2.727	24.273	0.43 c	D
Fluoranthene	141.818	3.764	30.927	54.0 n	M
Anthracene	225.000	14.250	40.950	410.0 n	None
Benzo(a)pyrene	42.857	3.129	16.929	0.00043 c	D
Pyrene	109.091	2.509	25.091	41.0 n	M

Notes:

D = Denotes minimum concentration exceeds screening concentration.
X = Denotes mean concentration exceeds screening concentration.
M = Denotes maximum concentrations exceeds screening concentration.
c = Carcinogen based screening value.
n = Non-carcinogen based screening value.

— TBP calculations are steady state calculations used to predict the accumulation of contaminants at an equilibrium. Based on the potential for exposure to other sediments and the frequency of detection of these contaminants, actual tissue concentrations would be expected to be much less than indicated by the TBP calculations above.
— Calculations above were performed based on 1.5 percent lipid (edible portion) obtained from correspondence by Martin Arhelger of Espey, Huston, & Associates, Inc. to USACE.
— TOC concentrations used in the model are parameter - specific mean TOC; for each parameter detected, the TOC for that location was included in the mean TOC for that sediment/parameter.
— USEPA Region III Screening Concentrations were presented previously in Table 5-2.

Table 5-5
Chronic Daily Intake Based on Tissue Concentrations Predicted by the TBP Model (previously presented in Table 5-4)
NAS Pensacola, Site 2
Pensacola, Florida

Parameters	Chronic Daily Intake based on Non-carcinogens (mg/kg-d)						Chronic Daily Intake based on Carcinogens (mg/kg-d)					
	@ Max Adult	@ Max Child	@ Min Adult	@ Min Child	@ Mean Adult	@ Mean Child	@ Max Adult	@ Max Child	@ Min Adult	@ Min Child	@ Mean Adult	@ Mean Child
DDD	2.6E-04	2.3E-03	1.2E-04	1.0E-03	1.7E-04	1.5E-03	1.1E-04	2.0E-04	9.6E-05	8.9E-05	7.3E-05	1.3E-04
DDT	1.5E-03	1.3E-02	1.9E-04	1.7E-03	6.6E-04	5.8E-03	6.5E-04	1.1E-03	1.6E-04	1.5E-04	2.8E-04	5.0E-04
PCB (1242 & 1260)	3.6E-03	3.2E-02	1.3E-03	1.1E-02	2.5E-03	2.2E-02	1.6E-03	2.7E-03	1.0E-03	9.6E-04	1.1E-03	1.9E-03
Benzo(a)anthracene	1.6E-02	1.4E-01	5.7E-04	5.0E-03	4.7E-03	4.2E-02	6.8E-03	1.2E-02	4.6E-04	4.3E-04	2.0E-03	3.6E-03
Benzo(b)fluoranthene	2.2E-02	2.0E-01	7.8E-04	6.8E-03	5.2E-03	4.6E-02	9.6E-03	1.7E-02	6.3E-04	5.9E-04	2.2E-03	3.9E-03
Benzo(k)fluoranthene	1.3E-02	1.2E-01	8.1E-04	7.1E-03	4.1E-03	3.6E-02	5.7E-03	9.9E-03	6.6E-04	6.1E-04	1.7E-03	3.1E-03
Chrysene	2.4E-02	2.1E-01	6.0E-04	5.3E-03	5.3E-03	4.7E-02	1.0E-02	1.8E-02	4.8E-04	4.5E-04	2.3E-03	4.0E-03
Fluoranthene	3.1E-02	2.7E-01	8.3E-04	7.3E-03	6.8E-03	6.0E-02	1.3E-02	2.3E-02	6.7E-04	6.2E-04	2.9E-03	5.1E-03
Anthracene	4.9E-02	4.3E-01	3.1E-03	2.8E-02	9.0E-03	7.9E-02	2.1E-02	3.7E-02	2.5E-03	2.4E-03	3.9E-03	6.8E-03
Benzo(a)pyrene	9.4E-03	8.3E-02	6.9E-04	6.0E-03	3.7E-03	3.3E-02	4.0E-03	7.1E-03	5.6E-04	5.2E-04	1.6E-03	2.8E-03
Pyrene	2.4E-02	2.1E-01	5.5E-04	4.9E-03	5.5E-03	4.9E-02	1.0E-02	1.8E-02	4.5E-04	4.2E-04	2.4E-03	4.2E-03

Notes:

— CDI calculations based on TBP estimates of tissue concentrations.
— 104 days per year for 30 years (adult) and 196 days per year for 6 years (child) based on all weekends in a year (which includes summer vacation for children).
— 54 g per day tissue consumption was assumed for blue crab.
— Adult body weight, 70 kg; body weight for child, 15 kg.
— Percent fat (lipid) for blue crab = 1.5 percent (edible portion) based on letter from Martin Arhelger of Espey, Huston & Associates, Inc.
— Sex-dependent variance may seasonally occur in the percent lipid values; therefore, the maximum percent lipid was used as a conservative estimate.

The USEPA has established a classification system for rating the potential carcinogenicity of environmental contaminants based on the weight of scientific evidence. Cancer weight-of-evidence class "A" (human carcinogens) means that human toxicological data indicate a proven correlation between exposure and the onset of cancer (in varying forms). The "B1" classification indicates that some human exposure studies have implicated the compound as a carcinogen. Weight-of-evidence class "B2" indicates a possible human carcinogen, and this classification was based on positive laboratory animal data (for carcinogenicity) in the absence of human data. Weight-of-evidence class "C" identifies possible human carcinogens, and class "D" indicates a compound is not classifiable with respect to its carcinogenic potential. The USEPA has established Slope Factors (SF_o) for carcinogenic compounds. The SF_o is defined as a "plausible upper-bound estimate of the probability of cancer incidence per unit intake of a chemical over a lifetime."

In addition to potential carcinogenic effects, most substances also can produce other toxic responses at doses greater than experimentally-derived threshold levels. The USEPA has derived Reference Dose (RfD) values for these substances. A chronic RfD is as "an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime." These toxicological values are used in risk formulae to assess the upperbound level of cancer risk and non-cancer hazard associated with exposure to a given contamination concentration.

For some compounds, no toxicological information was readily available. In these instances, ARARs were reviewed to provide a reference point. Both state and federal Surface Water Quality Criteria were discussed previously, including sediment criteria, National Status and Trends data, and screening concentrations. Drinking water Maximum Contaminant Levels (MCLs) and Secondary MCLs have been established for a number of contaminants. Table 5-6, presented in the next section shows the available risk/hazard information used to calculate

risk/hazard. State and federal water quality criteria and other ARARs were compared to surface water and sediment chemistry results in Section 4 of this memorandum.

5.5 Risk Characterization

The objective of the risk characterization is to estimate the overall potential adverse effect by using the exposure information and dose-response data for each exposure scenario. The risk is estimated by comparing of incremental excess cancer risk and hazard index to threshold values agreed on by the FDEP, USEPA, and the Navy. Risk characterization provides numerical estimates of risk and/or hazard and a framework to help judge its significance; and to assess and convey related uncertainties. The incremental excess lifetime cancer risk (ILCR) and hazard index (HI) are presented for each applicable medium. The predicted exposure concentrations are evaluated relative to internal dose and toxicological responses. Data for each reasonable route of exposure are compared with generally accepted safe concentrations. Contaminant-specific standards that are ARARs are used, when available, to determine acceptable concentrations. When ARARs are not available or sufficiently protective for specific compounds or exposure media, health-based concentrations are determined by using USEPA RfDs for non-carcinogens and USEPA SFs for carcinogens. The general exposure pathways and, thus, risk/hazard are presented as default values; however, as circumstances dictate, the default values can be changed to account for site-specific conditions.

The formulae below show the risk/hazard calculation using CDI (as defined in the Section 5.3 of this memorandum:

Risk:
$CDI_{oral} \times SF_o = \text{excess cancer risk}$

Hazard:
$CDI_{oral} / RfD_o = \text{Hazard Quotient}$

As shown above, the potential risk posed by a carcinogen is computed by multiplying the chronic daily intake (CDI in milligrams per kilogram per day [mg/kg/day]) by the SF in $(mg/kg/day)^{-1}$.

The hazard quotient (for toxicological effects other than carcinogenicity) is computed by dividing the CDI by the RfD (in mg/kg/day). The USEPA has set standard limits (or points of departure) for carcinogens and non-carcinogens to evaluate whether significant risk is posed by a contaminant (or combination of contaminants). For carcinogens, the typical point-of-departure range is 10^{-4} to 10^{-6}. These points of departure correlate with one in 10,000 and one in 1,000,000 excess cancer resulting from exposure to environmental contaminants. For non-carcinogens, other toxic effects are generally considered possible if the hazard quotient exceeds unity (1). Although both cancer risk and non-cancer hazard are generally additive (within each group) only if the target organ, effect, and/or mechanism of action are common to multiple contaminants, a most conservative estimate of each may be obtained by summing the individual risks or hazards. This PHRA first takes the universal summation approach suggested in RAGS. However, as discussed above, it may be appropriate to use the summation approach only for each toxicant exhibiting the same effect(s) by the same mechanism(s) of action. The presence of competitive inhibition (or inhibition of toxicity via an indirect mechanism) and synergistic effects are not addressed as no means of accurately predicting these effects has been universally accepted by the regulatory and scientific community.

The risk/hazard posed by the concentrations calculated using the TBP model are presented in Table 5-6. As shown in the table, the minimum concentrations computed for most parameters appear to pose significant risk and hazard. The HI for an adult (based on the minimum concentrations detected and subsequent TBP calculation) is 6.3, which exceeds the USEPA and FDEP hazard threshold of 1.0. In addition, the ILCR posed by those same concentrations exceeds the USEPA and FDEP point of departure for ILCR, 1E-6. The ILRC is primarily attributable to benzo(a)pyrene, a PAH that is not expected to significantly bioaccumulate in most organisms. The primary contributor to HI is DDT which, unlike PAHs, would be expected to accumulate in some organisms. It is important to note that actual tissue concentrations would

Table 5-6
Risk/Hazard Based on Tissue Concentrations Predicted by TBP
Tissue Ingestion Exposure Pathway (See Tables 5-4 and 5-5)
NAS Pensacola, Site 2
Pensacola, Florida

Parameter	Reference Dose	Slope Factor	Hazard Quotient based on 54 g per day fish consumption						Excess Cancer Risk based on 54 g per day fish consumption					
			@ Max Adult	@ Max Child	@ Min Adult	@ Min Child	@ Mean Adult	@ Mean Child	@ Max Adult	@ Max Child	@ Min Adult	@ Min Child	@ Mean Adult	@ Mean Child
DDD	5E-05	0.24	5.28	46.4	2.37	20.88	3.43	30.16	2.7E-05	4.8E-05	2.3E-05	2.1E-05	1.8E-05	3.1E-05
DDT	5E-05	0.34	30.33	266.77	3.89	34.22	13.19	115.99	2.2E-04	3.9E-04	5.3E-05	5.0E-05	9.6E-05	1.7E-04
PCB (1242 & 1260)	0.07	NA	0.05	0.46	0.02	0.16	0.04	0.31	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	7.3E-01	NA	NA	NA	NA	NA	NA	5.0E-03	8.7E-03	3.3E-04	3.1E-04	1.5E-03	2.6E-03
Benzo(b)fluoranthene	NA	7.3E-01	NA	NA	NA	NA	NA	NA	7.0E-03	1.2E-02	4.6E-04	4.3E-04	1.6E-03	2.9E-03
Benzo(k)fluoranthene	NA	7.3E-01	NA	NA	NA	NA	NA	NA	4.1E-03	7.3E-03	4.8E-04	4.5E-04	1.3E-03	2.2E-03
Chrysene	NA	7.3E-02	NA	NA	NA	NA	NA	NA	7.5E-04	1.3E-03	3.5E-05	3.3E-05	1.7E-04	2.9E-04
Fluoranthene	0.04	NA	0.78	6.85	0.02	0.18	0.17	1.49	NA	NA	NA	NA	NA	NA
Anthracene	0.3	NA	0.16	1.45	0.01	0.09	0.03	0.26	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	7.3	NA	NA	NA	NA	NA	NA	2.9E-02	5.2E-02	4.1E-03	3.8E-03	1.2E-02	2.0E-02
Pyrene	0.03	NA	0.8	0.16	0.02	0.16	0.18	1.62	NA	NA	NA	NA	NA	NA
Hazard Index			37.4	329.0	6.3	55.7	17.0	149.8						
Incremental Excess Cancer Risk									5E-02	8E-02	5E-03	5E-03	2E-02	3E-02

Notes:

— The above risk is based on the following assumptions: PAHs accumulate in the blue crab, the chemical composition of the organic parameters is not physiologically altered by the enzymes of the blue crabs, the lipid fraction (1.5 percent) remains constant regardless of sex or season, contaminants are completely unavailable, and no process affecting the kinetic uptake/elimination takes place.
— The Integrated Risk Information System (IRIS) was a primary source for the risk information above.
— The Health Effects Summary Tables (HEAST) were a secondary source for the risk information above.
— The one-hit risk model, excerpted from RAGS, was used to calculate risk for all parameters that exceed 1E-2 risk.

be significantly lower than those predicted by the TBP model (McFarland, 1994), and the resulting risk/hazard could be within acceptable thresholds. This is discussed further in Section 5.6, Uncertainty Discussion.

5.6 Uncertainty Discussion

The uncertainty discussion's objective is to introduce the evaluation of uncertainties inherent in the risk assessment process. Uncertainty is a factor in each step of the exposure and toxicity assessments presented in the preceding sections. Uncertainties associated with the initial stages of the risk assessment process become magnified when they are associated with other uncertainties. For example, the use of modifying factors and uncertainty factors, which range from 1 to greater than 1000, is a method commonly used to reduce uncertainty for sensitive subpopulations, species variances, etc. The uncertainty or modifying factors applied to a COPC become the "safety factor" for that COPC. During the risk characterization process, the risk is added to determine the ILCR for each exposure pathway. If ILCR and HI are summed within a medium, the "safety factor" of the incremental risk is the sum of all the individual "safety factors". This multiplicative or exponential conservatism is inherent in the risk assessment process, and is also evident in the uncertainty and modifying factors applied to RfDs. It is not possible to eliminate all uncertainties; however, recognizing the uncertainties is fundamental to the understanding and using risk assessment results.

This section also includes discussion regarding the uncertainty of site-specific and medium-specific factors introduced in the risk assessment, in addition to other factors influencing the uncertainty of the calculated ILCRs and HIs. For example, 0.54 mg of fish tissue per day (a default upperbound assumption for tissue ingestion) are not likely to be consumed from one source. Other sources — such as restaurants, harvesting fish and shellfish from other locations, etc., — will typically account for a significant fraction of tissue consumed from offsite sources. Chronic, ubiquitous exposure to all contaminants detected was assumed for blue crabs. The

fraction of time/area onsite has not been included in the calculations, and 100 percent was assumed which could lead to overestimates for HI and ILCR.

In addition, the probability that a potential receptor, harvesting and ingesting blue crabs, would catch crabs exclusively at Site 2 would be expected to be low. This probability was assumed to be 100%. The crabs' environment was also assumed to be homogenous, and the water column change (such as that influenced by tidal or storm events) was not considered in this model. For the purpose of this memorandum, all concentrations detected were addressed regardless of detection frequency. These conservative assumptions have lead to the construction of an exposure scenario representing preferential exposure to heavily contaminated areas and subsequently skewed (greater) risk/hazard results. Although some uncertainty can be alleviated through comparison to background, sufficient background information does not exist for the elimination of COPCs from the PHRA. Specifically, inorganics such as arsenic and chromium would be expected to be present in seafood and ingested by the public. However, background tissue concentrations for Site 2 COPCs were not available, nor were representative sediment concentrations.

Because Site 2 is contiguous with the whole of Pensacola Bay, the size/volume of water available to fish in the area and other factors discussed below, the blue crab was selected as a model species. This organism does not traverse as great an area as many of the fish in Pensacola Bay, and crabbing is fairly common to the region. Chronic blue crab exposure to Site 2 sediment is more likely than the sediment exposure of many other species. In addition, the potential for this organism to accumulate PAHs exists whereas vertebrates would not be expected to do so. Enzymes which metabolize PAHs (reducing the bioaccumulation potential) in vertebrates are not present in invertebrates such as the blue crab. Furthermore, the species is edible (by man) and is commonly harvested in this region of Florida.

As discussed in Section 5.3.2 of this document, the model depends on the percent lipid in the organism. For crabs, the maximum value of 1.5 percent was selected as a conservative estimate of the edible portion percent lipid due to variables which could affect the percent lipid. Seasonal changes, food variety and abundance, sex differences, and temporary hormonal fluctuations all could affect the percent lipid of any one organism. The concentration used in the model is the highest of all reported lipid concentrations for the blue crab. The COPCs included in the TBP model accumulate in the lipid portion of tissues, and higher lipid concentrations (and lower sediment TOC concentrations) increase the tissue concentrations predicted by TBP. For each incremental decrease in TOC, TBP increases four times.

Uncertainty specific to Site 2 is inherent using a model to predict tissue concentrations, and using those predicted concentrations to calculate risk/hazard would magnify uncertainty in the PHRA, as discussed. Due to the low TOC of the Site 2 sediments, the model cannot accurately predict tissue concentrations. The author of the model, Dr. Victor McFarland, was contacted (telephone conversation 6/24/94) regarding the applicability of TBP at low TOC. He stated that the low TOC evident in Site 2 sediments could result in a gross overestimate of tissue concentrations by the TBP model. Research is currently ongoing which will be used to determine a TOC range of applicability for the TBP model and to address binding phenomena on mineral surfaces, which may be a controlling factor in bioavailability when TOC is low.

Another source of uncertainty in TBP is the accumulation factor. According to Dr. McFarland, this factor was determined to be approximately one for COPCs such as PCBs and dioxins that are expected to accumulate in the lipid fraction of tissues. Although the blue crab would be expected to accumulate PAHs based on the species' lack of certain enzymes, Dr. McFarland also stated that the accumulation factor for PAHs would be much less than four, (on the order of 0.01 to 0.05). The accumulation factor used in the model was 4.0 (i.e. the default accumulation factor specified by USEPA). Risk/hazard projected based on chemical specific PF's would be expected to be much less than shown in Table 5-6. According to Dr. McFarland, this model

should be used only as an indicator or screen for further investigation in areas with TOC concentrations reported at Site 2.

In addition, the model does not apply to inorganics, and tissue concentrations and resulting risk/hazard were not calculated for this group of COPCs. Although this model has not traditionally applied to PAHs, these COPCs were retained in the model due to potential accumulation in the selected indicator species.

5.7 Risk Summary

Using the minimum Site 2 sediment concentrations detected onsite, the risk/hazard predicted by the TBP-derived tissue concentrations exceed the USEPA and FDEP points of departure and hazard thresholds for the shellfish ingestion exposure pathway. Comparison to background concentrations was not possible due to the lack of available tissue and sediment data. The model was used only for screening purposes, and much uncertainty exists in these risk/hazard calculations. However, ILCR and HI based on the TBP model do indicate a potential concern for the ingestion of shellfish exposure pathway, and the need for further investigation is evident based on these results.

5.8 Conclusions

Applying the accumulation factor (4.0) at low TOC (such as is evident at Site 2) in TBP grossly overestimates tissue concentrations. Actual tissue concentrations and subsequent risk would be expected to be much less than those the TBP model predicts.

PAHs would not be expected to be a major accumulation/biomagnification concern. Other COPCs, such as lead, DDT, and PCB, would be much more likely to accumulate, and these COPCs exceed the sediment screening value (ER-L) at the minimum and/or mean concentrations detected onsite.

Additional analysis could introduce other COPCs (anthropogenic and naturally occurring) not associated with Site 2, and if these COPCs are determined to be in sufficient quantity in the reference areas, the newly introduced COPCs should be considered reference or background contamination.

6.0 RECOMMENDATIONS

As discussed in Section 4.0 of this memorandum, elevated concentrations of cadmium, copper, lead, and zinc are evident in Site 2 sediments. In addition, some organic parameters, such as PAHs, could be of concern. Although PCBs and pesticides were detected infrequently in Site 2 sediments, the concentrations reported could be of concern. Generally, the highest sediment concentrations were detected in the shallow and near-to-shore northeast section of the site. Water concentrations did not to exceed criteria, as discussed in Section 4.0.

Due to the exceedance of the FDEP and USEPA points of departure for risk and hazard, and exceedances of various sediment screening values, additional investigation relative to actual tissue concentrations is recommended. It is assumed that the application of the accumulation factor (4.0) at low TOC (such as is evident at Site 2) in TBP grossly overestimated tissue concentrations. Actual tissue concentrations and subsequent risk is expected to be much less than those predicted by the TBP model (McFarland, 1994).

Based on the screening results, it is recommended that tissues of blue crabs from the Site 2 area be analyzed, including the analysis of blue crab tissue from a reference area rather than performing additional uptake modeling. In addition, other indicator species, such as mollusca or polychaetes (having higher lipid content and therefore higher accumulation factors), could be sampled at and/or near this site to address potential migration/biomagnification. A demersal fish species could be an appropriate candidate to address food chain effects as they have been found to accumulate greater concentrations than macroinvertebrates (for those chemicals that readily accumulate). However, PAHs would not be expected to be a major

accumulation/biomagnification concern in most vertebrate species. Other COPCs, such as lead, DDT, and PCB, would more likely accumulate, and these COPCs exceed the sediment screening value (ER-L) at the minimum and/or mean concentrations detected onsite.

This recommended analysis could introduce other COPCs (anthropogenic and naturally occurring) not associated with Site 2, and if they are determined to be in sufficient quantity in the reference areas, the newly introduced COPCs should be considered reference or background contamination. Therefore, determining appropriate reference area(s) for Site 2 and/or Pensacola Bay is recommended.

An option to tissue analysis is the field-calibrated accumulation-factor screening approach. The time involved in such an effort would likely necessitate an extended RI deadline. In addition, the conclusions/recommendations of such a study could be to analyze tissue samples. Tissue analysis at this point in the RI process for NAS Pensacola Site 2 appears to be a timely and possibly cost-effective option, and useful for determining conclusions/recommendations in the RI.

Subsequent to tissue analysis, parameters which pose significant risk or hazard to human health or the environment (Potential Chemicals of Concern) should be further delineated.

7.0 CRAB TISSUE SAMPLING

Based on data from the initial contaminant survey and recommendations from the risk assessment portions of the RI, a study was initiated to collect blue crabs for tissue analysis. This study was directed at determining the human health risk that may be present due to local recreational and commercial fishing for the species in the Site 2 vicinity. The following sections provide detailed information on procedures used to collect, transport and analyze crab tissue.

Field/Laboratory Procedures

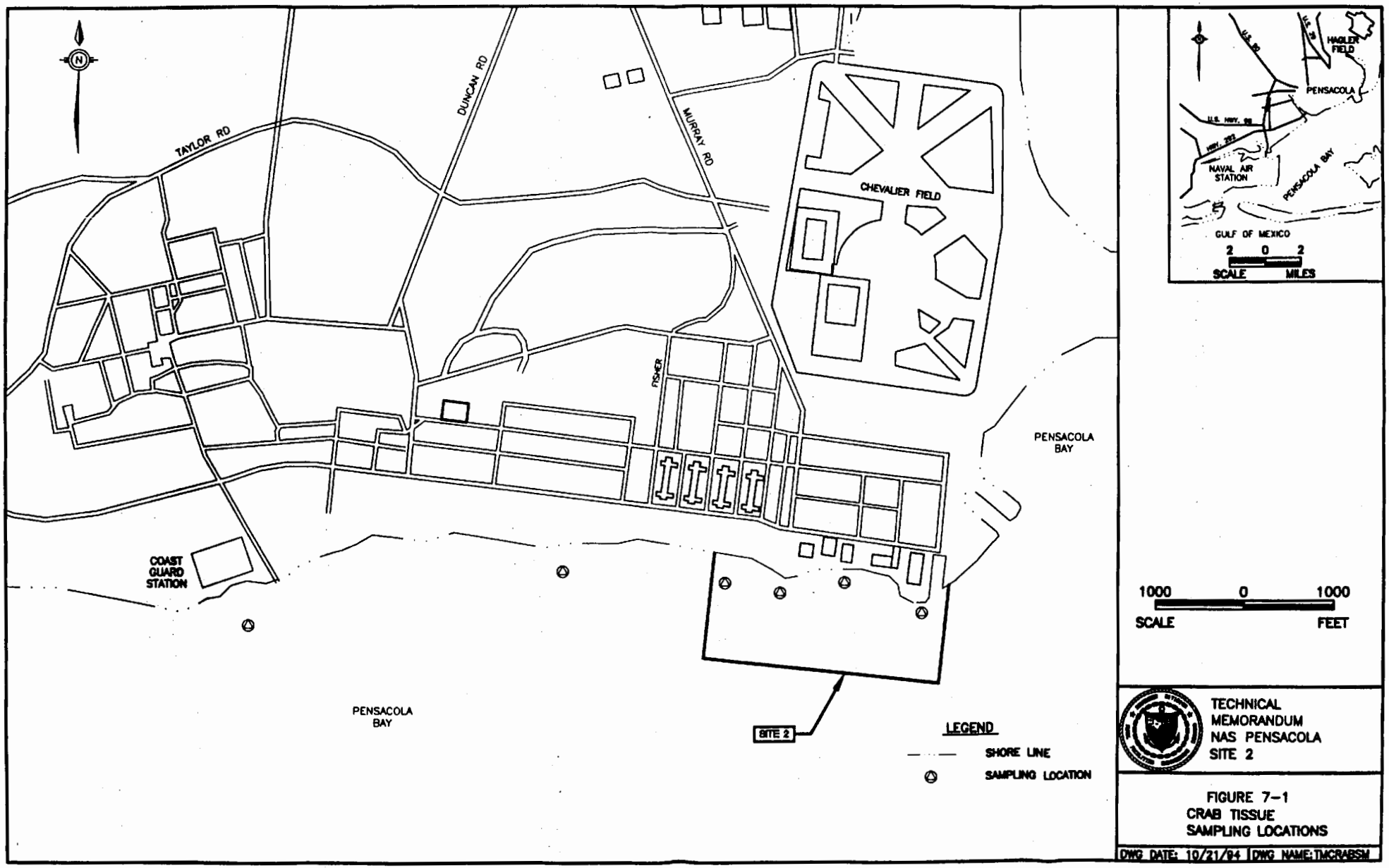
Prior to collection of crabs from the bay, sampling equipment was decontaminated to reduce the likelihood of cross contamination. Ice chests, stainless steel buckets, and crab tongs were first washed with soap and water, rinsed with hexane and then rinsed again with deionized (DI) water. Equipment was then sealed to prevent contamination during transport to the field.

Ten new crab traps were purchased and rinsed repeatedly with DI water to remove any visual contamination. Traps were then transported by boat to locations previously identified for crab sampling (Figure 7-1). These locations were selected to best represent both the spatial contamination trend observed during the RI process and to provide information on fishable areas along the seawall.

Traps were baited with menhaden purchased from a local fish market and placed on the bottom. On three consecutive days the traps were checked and emptied. Crabs collected each day were placed on ice in stainless steel buckets and labeled with station, time of day, and Loran C readings for the location.

Crabs were transported to the field laboratory at NAS Pensacola and processed. Total length (carapace width), sex and maturation stage was recorded. Crabs were then wrapped in aluminum foil which had previously been DI water/hexane rinsed. Wrapped crabs were placed in DI water/hexane rinsed Ziploc bags and placed in a freezer. Ziploc bags were labeled with the sample number on the outside in addition to a tag on the inside.

Crabs were processed as above until a sufficient number (12 to 14) per location were collected. Finally, frozen crabs were packed in ice chests and shipped overnight to Savannah Laboratory in Savannah, Georgia.


TAYLOR RD
DUNCAN RD
MURRAY RD
CHEVALIER FIELD
FISHER
PENSACOLA BAY
COAST GUARD STATION
PENSACOLA BAY
SITE 2
LEGEND
SHORE LINE
SAMPLING LOCATION
HAGLER FIELD
PENSACOLA
U.S. HWY. 98
HWY. 292
NAVAL AIR STATION
PENSACOLA BAY
GULF OF MEXICO
2 0 2
SCALE MILES
1000 0 1000
SCALE FEET
TECHNICAL MEMORANDUM
NAS PENSACOLA
SITE 2
FIGURE 7-1
CRAB TISSUE
SAMPLING LOCATIONS
DWG DATE: 10/21/94
DWG NAME: TMCRABSM

Laboratory processing will include excising of edible tissue from the cephalothorax and chelipeds. Approximately 100 grams of tissue will be used in analysis of semi-volatile organics, pesticides, and metals using EPA Contract Laboratory Program (CLP) protocols.

8.0 REFERENCES

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FLORIDA PROFESSIONAL GEOLOGIST SEAL

I have read and approve of this Technical Memorandum for Site 2 and seal it in accordance with Chapter 492 of the Florida Statutes. In sealing this document, I certify the geological information contained in it is true to the best of my knowledge and the geological methods and procedures included herein are consistent with currently accepted geological practices.

Name:	Steven J. Parker
License Number:	#1651
State:	Florida
Expiration Date:	July 31, 1996

Steven J. Parker

11-7-94

Date